



# Sustainable Energy in America 2025 Factbook

Tracking Market & Policy Trends

**BloombergNEF**

 **The Business Council  
for Sustainable Energy®**

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# Table of contents



<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>		
			<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	

# About the Factbook, and updates to this edition

## What is it?

- This Factbook **aims to augment existing public sources** of information on US energy.
- In most cases, it **employs BloombergNEF data**. Additional data from the US Energy Information Administration (EIA), the Environmental Protection Agency (EPA), the Federal Energy Regulatory Commission (FERC), the American Council for an Energy-Efficient Economy (ACEEE), Lawrence Berkeley National Laboratory and other sources are also utilized where necessary.
- This report **focuses on renewables, efficiency, natural gas, distributed power and storage, and sustainable transportation**. It also **fills important data gaps** in certain areas, such as clean energy investment flows and distributed energy.
- Updated yearly, the Factbook **draws on the latest information on new energy technology costs**. Wherever possible, it **contains data through the end of 2024**.
- This is the 13th edition of the Factbook, which was first published in January 2013. It **has been graciously underwritten by the Business Council for Sustainable Energy** with the help of supporting sponsors.

## What's new?

- This year's report contains new data on carbon markets – voluntary as well as compliance carbon markets – as well as data on regions of the US where load has grown.

# About the Factbook: Sponsorship



The Business Council for Sustainable Energy (BCSE) is a coalition of companies and trade associations from the energy efficiency, natural gas, and renewable energy sectors. It includes independent electric power providers in energy and environmental markets. Founded in 1992, the coalition's diverse business membership is united around the continued revitalization of the economy and the creation of a secure and reliable energy future in America. The *Sustainable Energy in America Factbook* is commissioned by the BCSE and supported by the generous contributions of the following sponsors: Amazon, American Clean Power Association, American Gas Association, Copper Development Association, CRES Forum, Johnson Controls, JPMorgan Chase & Co., McKnight Foundation, National Grid, National Hydropower Association, Net Power, Polyisocyanurate Insulation Manufacturers Association, Sacramento Municipal Utility District, Schneider Electric, Reworld, Sempra, Solar Energy Industries Association, Trane Technologies, and Washington Gas.

# Table of contents



<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>		
			<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	



# Executive summary (1 of 6)

## Sustainable energy technologies in the US are ready to meet increasing energy demand

Energy growth has returned to the US power system. Between 2009 and 2024, the compound annual growth rate for electricity sales in the country was 0.6%, or roughly flat. This changed in 2024, with rapidly rising expectations of power demand from new industrial sources and transportation, onshoring of US manufacturing, and a burst of new data centers planned by tech companies in the race for artificial intelligence mastery.

These expectations, coupled with an increasing number of electricity markets facing capacity constraints, have changed the focus of US energy system planning. Regulators, utilities and energy providers alike are looking to bring new sources of power online quickly, and are calling on an increasingly diverse mix of energy resources to meet these needs.

Investment and deployment continued to rise across the power sector last year, especially in the areas of renewable energy, energy storage, energy efficiency, natural gas and sustainable transportation. Strong federal and state policy signals from past years translated to steady investment: an estimated \$99 billion of federal funding was announced in 2024. The elections last November marked a shift in federal policy priorities, but leveraging the US's energy abundance and maintaining competitiveness in a changing energy landscape remain a focus.

Domestic supply chains are also ramping up, in response to a series of onshoring policies put in place over the past few years. However, not all policy efforts have borne fruit, and clean the hydrogen, carbon capture, and wind sectors are growing more slowly than expected as they await policy guidance and certainty.

## Long-term trends locked in, supporting increased diversification

### The construction of new renewable power grew, and solar set records

The US economy expanded by 2.8% last year, while primary energy consumption increased by just 0.5%. In other words, the US's "energy productivity" (the ratio of US GDP to total US energy consumption) increased by 2.3% year-on-year to reach the highest economic output achieved per unit of energy consumed to date.

### US natural gas demand reaches a record, with LNG and power demand driving growth

Demand for US natural gas rose 1.3% year-on-year to reach a record 99.7 billion cubic feet per day (Bcf/d). Demand for natural gas exports – both on ships as liquefied natural gas (LNG), as well as pipeline gas to Mexico – also rose, along with power demand. Yet a warmer-than-normal winter over 2023-24 saw lower gas consumption for heating in residential and commercial buildings. This in turn led to higher levels of natural gas reserves in underground storage, which pushed prices down. The Henry Hub front month contract fell as low as \$1.38 per million British thermal units (MMBtu), marking the second price decline since the highs of 2022.

# Executive summary (2 of 6)

## Renewable energy broke records, with solar leading the pack

Renewable energy sources met a record volume of US energy demand in 2024. The combined contribution of wind, solar, biomass, waste-to-energy, geothermal and hydropower rose at the fastest pace among all sources of energy. In power, renewables were the second-largest source of power generation, contributing 1,063 terawatt-hours (TWh), second only to natural gas at 1,885TWh. Record levels of solar capacity additions helped push renewable sources to 24% of US power generation, and pushed zero-carbon power (renewables plus nuclear power) to an all-time high of 42%.

The US added a record 49 gigawatts (GW) of new solar power-generating capacity to its grid in 2024, including distributed rooftop generation on homes and businesses. The market has absorbed the uncertainty around tariffs, supply chain scrutiny and higher interest rates to deliver record-setting volumes of new capacity. Buoyed by strong demand from utilities and corporate buyers, the technology is one of the cheapest sources of new bulk generation even without tax credits.

## Energy storage deployment set new records

The US commissioned an estimated 11.9GW of battery energy storage in 2024, including utility-scale capacity as well as distributed systems in homes and businesses. Battery storage additions jumped by 55% year-on-year, making it the fifth straight year of record-setting annual additions. Development incentives through the Inflation Reduction Act (IRA) and falling costs of batteries due to fierce competition among battery manufacturers drove this high buildout, making the US the world's second-largest battery storage market after China.

Globally, growing interest in long-duration storage led to record buildout in 2024. The first nine months of the year saw global installed capacity exceed 1GW (4.6 gigawatt-hours in energy capacity terms) for the first time. China has the largest installed base, with the US in fourth place globally.

Pumped hydropower energy storage remains the largest source of storage currently available on the power grid in terms of the total amount of energy that can be stored. However, in 2024, cumulative battery capacity in the US reached 31.5GW, compared with 23.2GW of pumped hydropower, meaning that for the first time batteries can provide more instantaneous power to the grid than any other source of storage.

# Executive summary (3 of 6)

## **Electric vehicle sales grew, with legacy automakers taking on a bigger role**

Sales of electric vehicles (EVs) set a new record in 2024, seeing 6.5% growth year-on-year. With over 1.5 million EVs sold in the US, one in 10 new cars registered last year came with a plug. Tesla remained the largest player, despite seeing its market share slide to 38% from 42% the prior year, largely due to its aging lineup of models. The slowdown in performance by the market leader dragged down the country's overall sales, obscuring double-digit growth rates by legacy automakers such as GM and Ford. The US EV market is steadily diversifying from outright dominance by a single firm; Stellantis NV, Ford and GM all saw their electric vehicle sales rise year-on-year.

## **Renewable fuels and biofuels grow, seeing more supply and demand**

US renewable natural gas (RNG) supply and demand are both increasing, bolstered by the federal Renewable Fuel Standard and California's Low Carbon Fuel Standard (LCFS). In addition, investment tax credits included in the IRA can offset the cost of new-build RNG facilities by 6-30% of eligible costs. Transportation remains the largest end-use market for RNG by volume, and the renewable fuel accounted for 70% of the sector's natural gas consumption last year. While some utilities offer renewable natural gas for homes and businesses at a cost premium, growth in this use case remains slower than in transport.

Production of renewable jet fuel, also called sustainable aviation fuel (SAF), soared 325% in 2024, thanks to investment tax credits under the IRA. While production has taken off dramatically, future demand ultimately depends on the appetite of airline customers. While some corporates, looking to reduce their scope 3 emissions, are pushing for greener flights, these fuels come at a cost premium; since airlines cannot absorb the higher cost, they must pass it on to customers. Globally, 34 new agreements were signed to procure SAF in 2024, marking the second year of decline.

## **Manufacturing and investment respond to supply needs**

### **Manufacturing facility plans rise, battery manufacturing grows**

The number of manufacturing facilities planned in response to the IRA rose to 264 as of December 2024. Clean vehicle factories – representing both vehicle and battery assembly – saw the largest number of announcements, followed by solar and stationary storage facilities. Together these announcements represent over \$100 billion in investments.

Lithium-ion battery manufacturing capacity was of particular focus to produce cells for both stationary storage as well as automotive applications. By the end of 2024, the US had factories capable of producing 159 gigawatt-hours (GWh) of storage cells, a 39% year-on-year rise. Ultium's 35GWh plant in Tennessee was one of the major facilities that opened in 2024, intending to produce batteries for the auto industry.



# Executive summary (4 of 6)

## **Energy transition investment remains steady**

Investment into the technologies that are accelerating decarbonization increased slightly year-on-year, with the US spending \$338 billion on the energy transition, up from \$303 billion in 2023. These investments were dominated by clean power and grid-related spending. Globally, China was the country that spent the most on the energy transition, at an estimated 4.4% of its gross domestic product in 2024. The US spent an estimated 1.3% of 2024 GDP.

## **Energy efficiency spending rebounded after a post-pandemic drop**

Utility spending on energy efficiency reached its highest level in eight years, rebounding after the pandemic. In 2023, the last year for which there is complete data, spending rose 14% year-on-year to reach \$8.8 billion, according to data compiled by the American Council for an Energy-Efficient Economy (ACEEE). Spending on efficiency improvements related to both electricity and natural gas rose to all-time highs of \$6.9 billion and \$1.9 billion, respectively. The ACEEE estimated that electric utilities in 2023 saved 23.2TWh of energy, equivalent to 0.52% of retail sales.

## **Falling prices for natural gas, power keep costs low for consumers**

The two-year trend of falling natural gas prices translated into a decline in retail natural gas prices for residential, commercial and industrial consumers. Residential price adjustments tend to lag index prices by six to 12 months, depending on utility practices. Industrial prices tend to be most correlated to wholesale markets.

Wholesale power prices remained stable year-on-year in 2024, benefitting in part from falling natural gas prices, while average retail prices saw a modest 0.68% drop in 2024. While regional differences in retail prices remain large, energy accounted for just 3.8% of personal expenditures on average in 2024, down from 4.1% in 2023.

In 2023, the last year of complete data across countries, US industrial retail prices for power were the lower than four other countries in the Group of 7, while residential prices were lower than Germany and Japan.

# Executive summary (5 of 6)

## Waiting for clouds to clear

### Wind struggles

Both onshore and offshore wind struggled in 2024. Despite tax credits and support for new renewable energy deployment, onshore wind saw its fourth straight year of declining capacity additions. While tax credits through the IRA have revived interest in the sector, the regions where the tax credits have the most value are those where wind already has a high share of generation, meaning transmission congestion can hold back new build.

Offshore wind spent 2024 course-correcting after a harsh 2023, when inflation led to contract renegotiations and ultimately some project cancellations. Several projects made progress on new agreements to replace previously canceled ones, final investment decisions were made on 1.7GW of projects, and approvals to begin construction for 10.8GW of capacity were received. While the nascent industry appears to have turned a corner, further growth will depend on sustained support from federal and state policymakers.

### Generators wait on interconnection reform

Reforms are underway to expedite the process of connecting new power projects to the grid, but progress remains slow in comparison to how quickly queues fill up, especially when longer permitting processes are taken into account. Following an explosion in 2021-22 of new capacity seeking to connect to various US power grids, system operators are revising how projects are evaluated, costs are distributed, and new transmission infrastructure is planned and built. In 2024 alone, 317GW of new capacity applied to interconnect in the US, equivalent to nearly a third of the current installed US power system. Over two-thirds of this capacity is solar and storage.

### Clean hydrogen spends the year in limbo

Developers announced plans to bring 16.4 million tons of hydrogen-producing capacity online in 2024. Yet this 27% year-on-year rise was driven by the anticipation of federal support, and a shift in the new federal administration's energy priorities might affect what materializes. Of this announced capacity, 77% was 'blue', referring to thermochemical hydrogen produced from natural gas, and fitted with carbon capture to mitigate emissions. The low cost of US natural gas makes hydrogen with natural gas and carbon capture and storage (CCS) in the US cheaper than hydrogen produced electrolytically by zero-emission sources, like renewables and nuclear.

While developers last year announced plans to bring online 34.7GW of electrolyzer capacity to produce low carbon hydrogen in the US, a 7% increase on the prior year, the wait for final guidance on the tax credit meant that the US only had 0.079GW of electrolyzer capacity operating by the end of 2024. Given that hydrogen produced electrolytically by renewables and nuclear is the more expensive of the low-carbon hydrogen options, the generous 45V tax credit is important to bringing down costs for end-customers.

# Executive summary (6 of 6)

## **New sectors develop interest in carbon capture and storage**

The US is the global leader in carbon capture and storage (CCS), with 23 million metric tons per annum (Mtpa) of operational capacity, and the IRA has provided the most generous incentives in the world to capture carbon dioxide that is emitted into the atmosphere. However, this status quo has remained unchanged since 2020, with no meaningful new capacity brought online, especially when compared with the 146Mtpa of announced new capacity.

## **Climate impacts persist as emissions grow slightly**

### **The highest number of extreme weather events**

The impacts of climate change continue to be felt throughout the US, and 2024 saw the second-highest number of extreme weather events since 2010. The country experienced 27 climate-related disasters that together caused \$182.7 billion in damages in 2024. Five tropical cyclones accounted for 68% of the total disaster costs. Citizens and communities are installing a growing number of microgrids powered by solar, storage, natural gas and diesel generation sets to help mitigate the impact of these storms.

## **US emissions rose, driven by industry**

The US emitted 6,250 million metric tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) of greenhouse gases in 2024, according to BNEF estimates, representing a 0.5% increase year-on-year. Increased use of fossil fuels drove up emissions in industry, transport and agriculture, obscuring the slight decline in emissions from buildings. Industry is the second-largest and fastest-growing source of emissions due to rising natural gas use.

With limited adoption of low-carbon technology or fuels, industrial emissions accounted for 89% of the growth in national emissions in 2024. On the other hand, emissions in the sector with the most emissions – transport – remained below pre-pandemic levels. Lower gasoline consumption from drivers played a role, partially in response to higher prices at the pump post-pandemic. In addition, structural changes like persistent remote work flexibility reduced the need for commuting, and the associated gasoline-related emissions.

Power, which as recently as 2016 was the highest-emitting sector in the US, has now fallen to third place. Year-on-year, emissions remained unchanged even as power consumption rose, thanks to higher renewable energy and natural gas consumption and the steady decline of coal.

US emissions are now 15.8% lower than in 2005, while power emissions are 41% lower than 2005 levels.

# Quick facts (1 of 2)

*Here are some of the high-level findings from this year's Sustainable Energy in America Factbook*

## Investment and deployment

- **A record-breaking \$338 billion in energy transition financing was deployed in the US** for clean energy technologies, including renewables, electric vehicles and power grids.
- **Some 54 gigawatts of new renewable power-generating capacity was added to the US grid**, primarily driven by robust solar additions. Renewable energy use also set new highs: 9.2% of total US energy demand and 24% of electricity demand.
- **The US is the second-largest energy storage market in the world.** It commissioned an estimated 11.9GW of battery storage capacity in 2024 including large- and small-scale batteries, a new US record. China remained the world's largest storage market.
- **Electric vehicle sales crossed 1.5 million, growing by 6.5%.** Despite declining annual sales by market leader Tesla, strong growth by other automakers more than offset that drop.
- **The US led digitalization activities in the power sector.** Over 2023 and 2024, the US accounted for 43% of global projects and partnerships announced in power sector digitalization, in part driven by Department of Energy funding
- **Interest in “clean” US hydrogen is growing, but developers spent the year waiting for guidance.** The US had 79 megawatts of operational electrolyzer capacity at the end of 2024; developers have announced plans for another 34.7 gigawatts of clean hydrogen capacity in the coming years. The Department of Energy's hydrogen program allocated \$170 million for planning and analysis. This infrastructure is key to enabling hydrogen adoption and use.
- **Carbon capture plans are surging, but activity has stalled.** Plans are in place for 146 million metric tons per annum (Mtpa) of new projects, compared with an installed base of 23Mtpa in the US. This base has remained largely unchanged since 2020. Most of the new demand for carbon capture comes from diverse sectors like power generation, ammonia and hydrogen, ethanol production and chemicals, while current installations are primarily at natural gas processing facilities.
- **Renewable diesel and jet fuel supply rose 25% and 325% year-on-year, respectively.** Globally, airlines signed a total of 34 agreements to procure sustainable aviation fuel (SAF) from January to early December 2024. Incentives such as investment tax credits under the IRA support increased SAF production by lowering eligible costs by 6-30%.

# Quick facts (2 of 2)

## Energy trends and updates

- **US CO2 emissions were 0.5% higher in 2024 than in 2023**, BloombergNEF estimates. Transport remained the top-emitting sector, with industry second and power third.
- **US “energy productivity” set a new record in 2024** as economic growth outpaced energy consumption and grew 2.3% year-on-year. The trend is even starker over the past 10 years, during which GDP has grown by 27.6% while primary energy consumption has decreased 1.3%. The result: a 29.3% increase in productivity.
- **Total US energy consumption grew 0.5% year-on-year**, as the US consumed more electricity than ever before. More natural gas and renewables fueled this growth in power, even though petroleum remains the largest fuel consumed on an absolute basis across the economy.
- **Energy spending accounted for 3.8% of total US personal consumption expenditures in 2024**, down 0.3 percentage points from 2023 as the cost of motor fuel fell, along with a slight decline in the price of natural gas.
- **Inflation and higher interest rates boosted levelized costs of electricity (LCOEs) for renewable energy technologies** in 2023, the last year of complete data, but natural gas plants saw costs fall as the underlying price of the fuel fell year-on-year.
- **Demand for US natural gas rose 1.3% to reach 99.7 billion cubic feet per day**. The jump was led by stronger power sector demand and rising LNG exports, which offset modest declines across the commercial and residential sectors.
- **Corporations buying clean power set a new record in 2024**, signing up to buy 28 gigawatts of zero-carbon power. The year was marked by diversifying away from wind and solar, and a pivot toward partnerships and investment with nuclear plants.
- **Extreme weather events in the US were just below the prior year’s record, with 27 events resulting in \$182.7 billion in damages**. Tropical storms accounted for 69% of that total cost.
- **Coal’s contribution to power generation slid to 14.7% in 2024, the lowest level ever**. It was largely replaced by renewables, which produced an estimated 1,063 terawatt-hours of power in 2024, meeting 24.2% of 2024 power demand. The share of natural gas remained steady year on year, at 43% of the power generation mix.
- **Energy efficiency spending rose in 2023 (the last year with complete data)**. Utility spending on power and natural gas improvements rose 14.4% year-on-year to reach \$8.8 billion.

*These trends are discussed in far greater depth, and with graphic illustrations, in the Factbook itself.*

# Table of contents

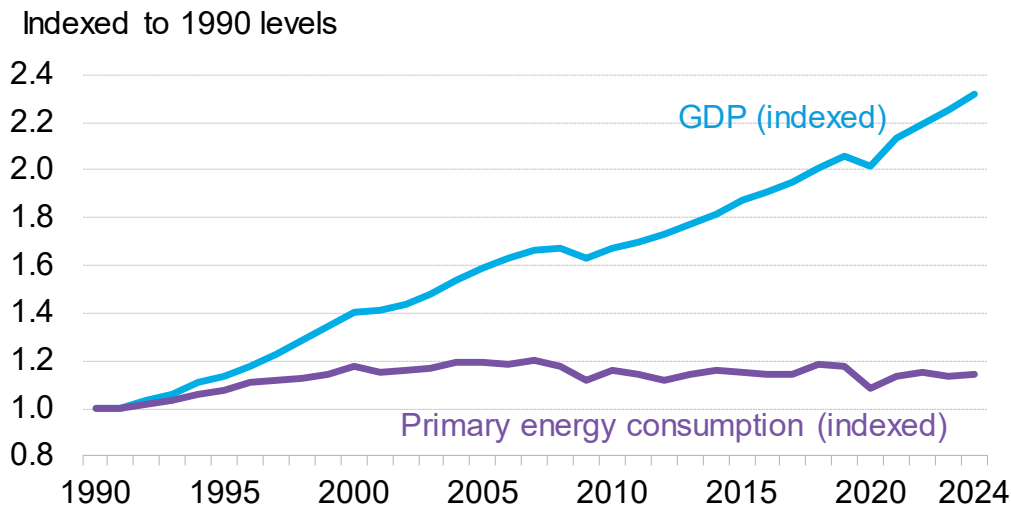


<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>		
			<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	

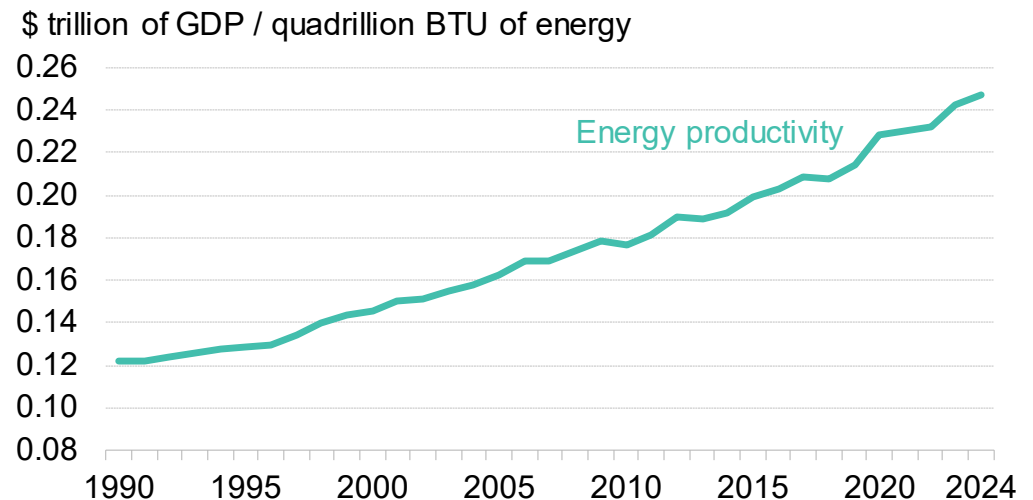


# US energy overview: Energy productivity

## US GDP (real) and primary energy consumption



## US energy productivity

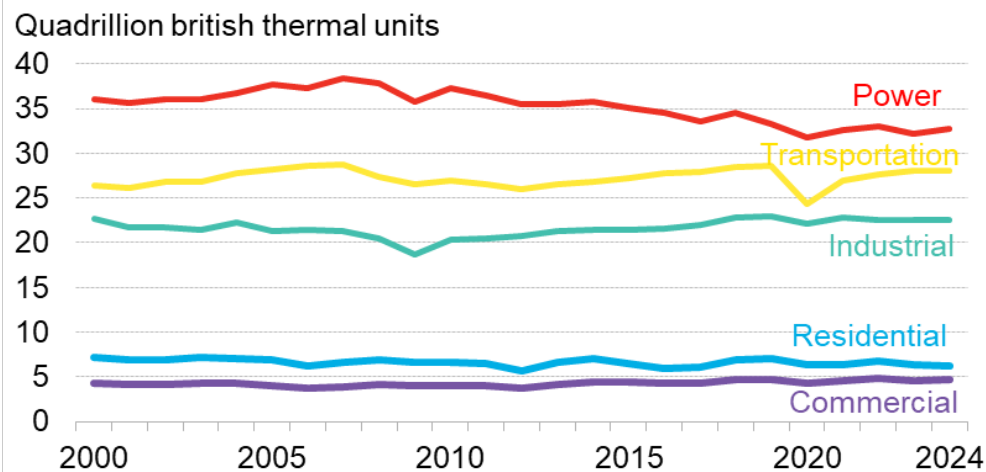


- The US economy expanded by 2.8% in 2024, while primary energy consumption increased just 0.5% year-on-year. This difference in growth rates resulted in an increase in “energy productivity”, defined as the ratio of US gross domestic product (GDP) to total US primary energy consumption, of approximately 2.3% last year. Taking a broader view, US GDP has grown 27.6% over the past 10 years, while primary energy consumption has decreased 1.3%, meaning US energy productivity has gone up 29.3% over the decade.
- The marginal rise in energy consumption last year was due to greater power generation, which offset declines in energy consumed across other sectors of the economy. The US generated 4,393 terawatt-hours of power last year, the highest figure since 2012. Natural gas was the primary source of power; renewable energy was second.

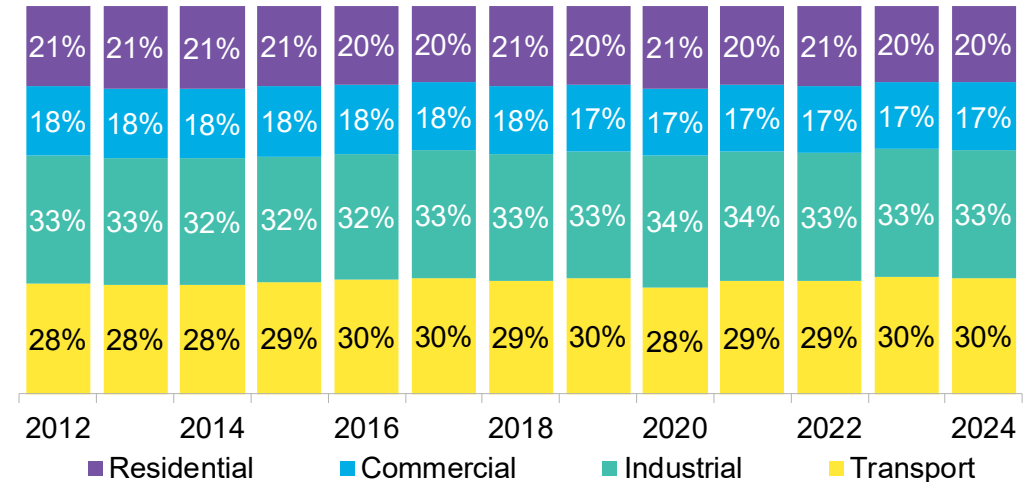
Source: Bureau of Economic Analysis, US Energy Information Administration, BloombergNEF. Note: Values for 2024 are projected, accounting for seasonality, based on latest monthly values from US Energy Information Administration (data available through September 2024). The 2024 gross domestic product (GDP) estimate is a projection from economists compiled at ECFC <GO> on the Bloomberg Terminal. BTU refers to British thermal units.

# US energy overview: Primary energy consumption, by sector

## US primary energy consumption



## US end-use energy consumption

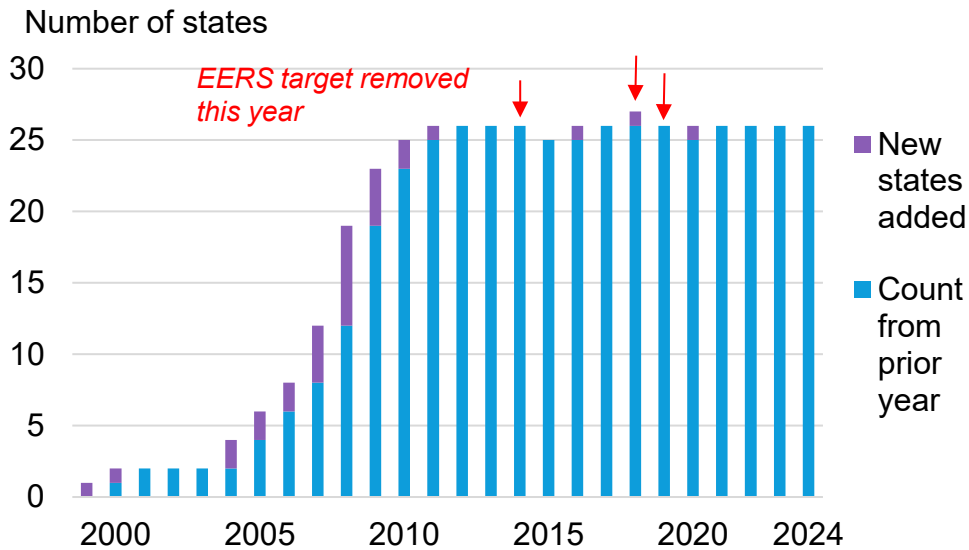


- Energy consumption from residential buildings decreased by 2.6% year-over-year, while commercial buildings saw a 0.7% increase during the same period. This trend has been a decade in the making, with residential buildings' energy use dropping by 11.6% since 2014 and commercial buildings' consumption rising by 6.8% over the same period.
- The energy consumption in both the industrial and transportation sectors remained largely steady year-on-year, seeing marginal increases of 0.05% and 0.08%, respectively, in 2024. Over the past decade, industrial energy consumption has grown by 5.0%. Energy used in transport is up 4.7% over the same time period, but remains below the pre-pandemic level in 2019.
- Energy consumed to produce power increased by 1.74% year-on-year, reaching 32.7 quadrillion British thermal units (BTU). This is an 8.6% decline over the past decade, maintaining the overall decline in power sector energy consumption since its peak at 38.5 BTU in 2007.
- Energy use from corresponding end uses as a proportion of total energy consumption remained unchanged from 2023 to 2024.

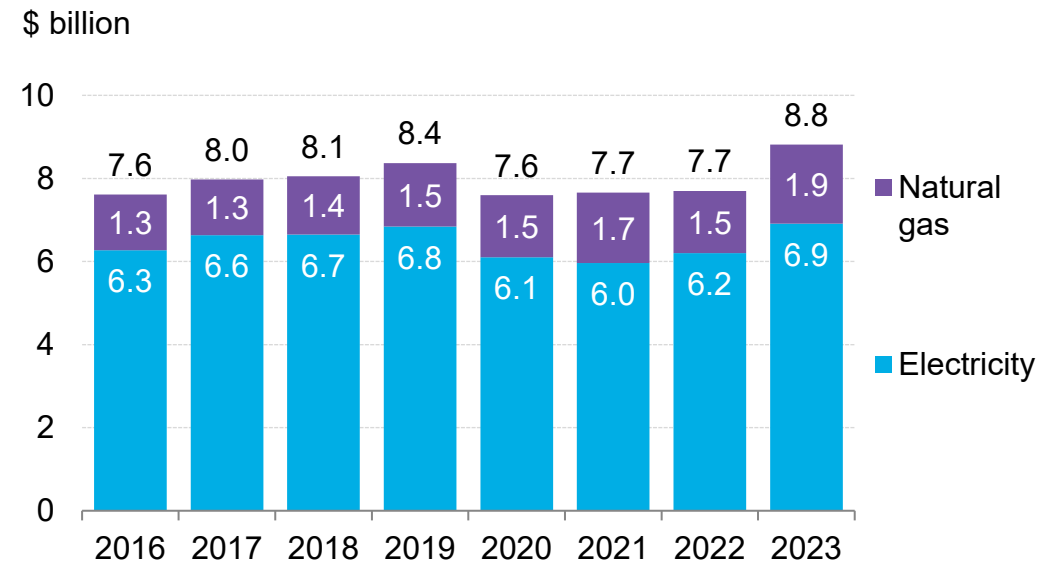
Source: US Energy Information Administration, EPA, BloombergNEF. Note: Values for 2024 are projected, accounting for seasonality, based on latest monthly values from the US Energy Information Administration (data available through September 2024). Electricity is excluded from industrial, residential, commercial and transportation sectors and aggregated in "power" in the left-hand chart. In the right-hand chart, sector end uses include electricity use.

# US energy overview: Energy efficiency

## US states with Energy Efficiency Resource Standards (EERS)



## Utility energy efficiency spending

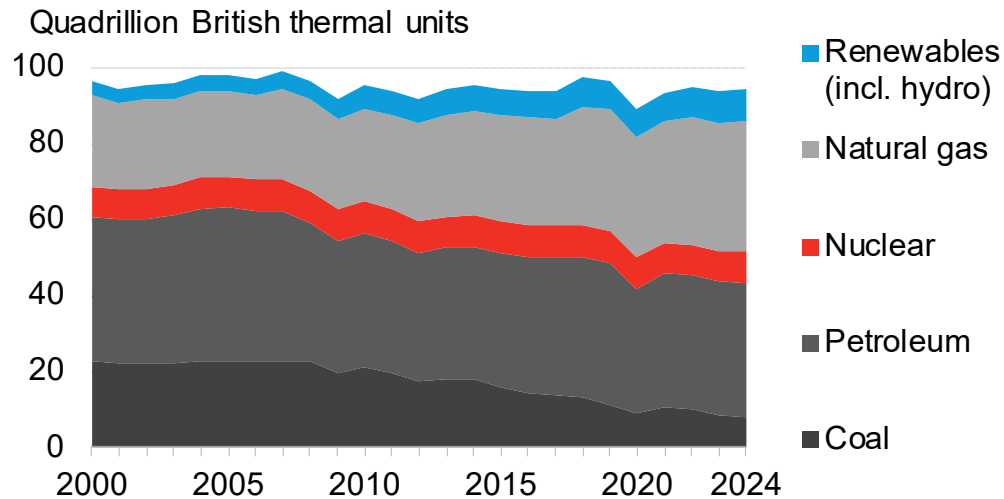


- Energy Efficiency resource standards (EERS) are state-level policies that require utilities to invest in measures to improve end-user efficiency, usually with an eye to meeting energy-savings goals set by the government. In 2024, 26 states and the District of Columbia had EERS policies in place.
- After a sharp drop in efficiency spending from 2019 to 2020 due to the pandemic, efficiency spending rose to pre-pandemic levels in 2023, the last year for which there is complete data. Spending rose 14.4% year-on-year from 2022 to 2023 to reach \$8.8 billion, according to data compiled by the American Council for an Energy-Efficient Economy (ACEEE).
- Spending on efficiency improvements related to electricity rose to the highest level in eight years, to \$6.9 billion in 2023, while spending on improving the efficiency of natural gas delivery reached a record \$1.9 billion.
- According to ACEEE, states with EERS in place accounted for 59% of overall US electricity sales in 2023. Across the US as a whole, in states with policies in place, energy savings exceeded state targets, even though some states over-achieved on their goals while others did not.

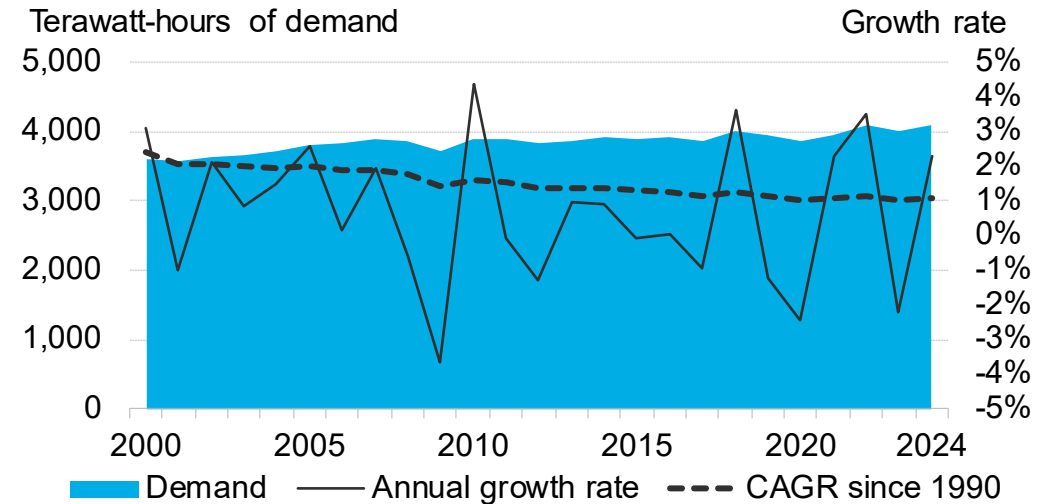
Source: American Council for an Energy-Efficient Economy (ACEEE) 'Next Generation Energy Efficiency Resource Standards Update (January 2025)', BloombergNEF

# US energy overview: Energy and electricity consumption

## US primary energy consumption, by fuel type



## US electricity demand

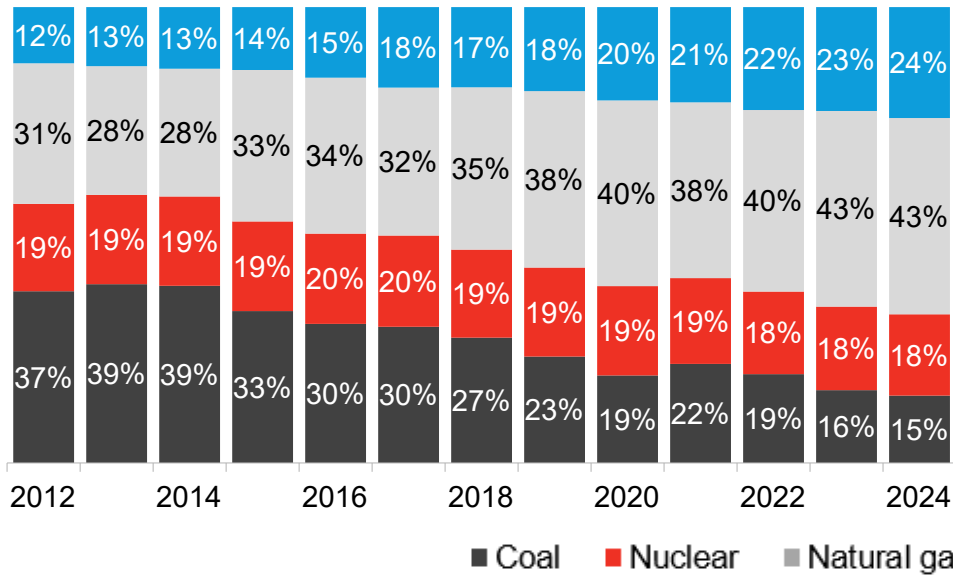


- US primary energy consumption grew 0.5% from 2023 to 2024, to an estimated 94.09 quadrillion BTU. This growth was met by increased reliance on renewables (including hydro), natural gas and nuclear, which were up 5.0%, 1.9% and 1.0% year-on-year, respectively.
- Coal consumption as a share of the US primary energy mix continued trending down, seeing a 4.8% year-on-year decrease. In 2024, coal accounted for 8.3% of the US energy mix, as opposed to 18.9% a decade ago. The gap was largely filled by natural gas and renewables (including hydro), whose respective share of US consumption was 36.35% and 8.3% this past year.
- Petroleum is the largest energy source in the US's consumption mix, totaling 35.38 quadrillion BTU in 2024, with natural gas a close second at 34.27 quadrillion BTU. Primarily used for various transport fuels, petroleum represented 37.5% of the US's primary energy consumption; despite a slight decline in consumption of 0.1% from 2023 to 2024, petroleum use has grown 2% over the past decade.
- Total retail demand for electricity climbed 1.8% year-on-year, and 4.6% over the past decade. Rising demand for electricity from industrial activity – data centers, the electrification of oil and gas production, and some reshoring of manufacturing – pushed up US electricity consumption. However, the rate of power demand growth has slowed over time; the compound annual growth rate (CAGR) for electricity demand between 1990 and the present day decreased from 1.3% in 2014 to 1.1% in 2024.

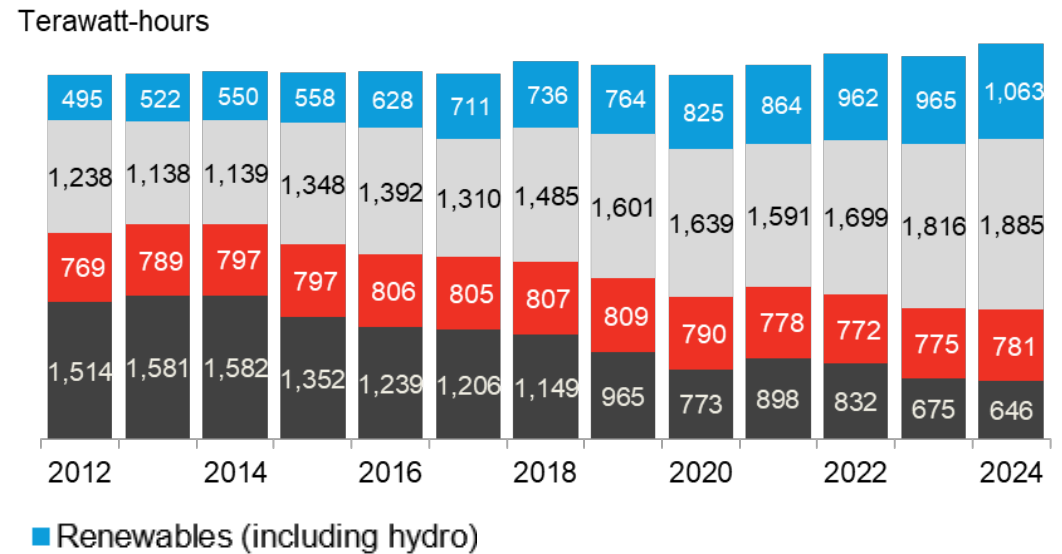
Source: US Energy Information Administration, BloombergNEF. Notes: "CAGR" in the right-hand chart is compound annual growth rate. Values for 2024 are projected, accounting for seasonality, based on the latest monthly values from the US Energy Information Administration (data available through September 2024).

# US energy overview: Electricity generation mix

Share of US electricity generation, by fuel type



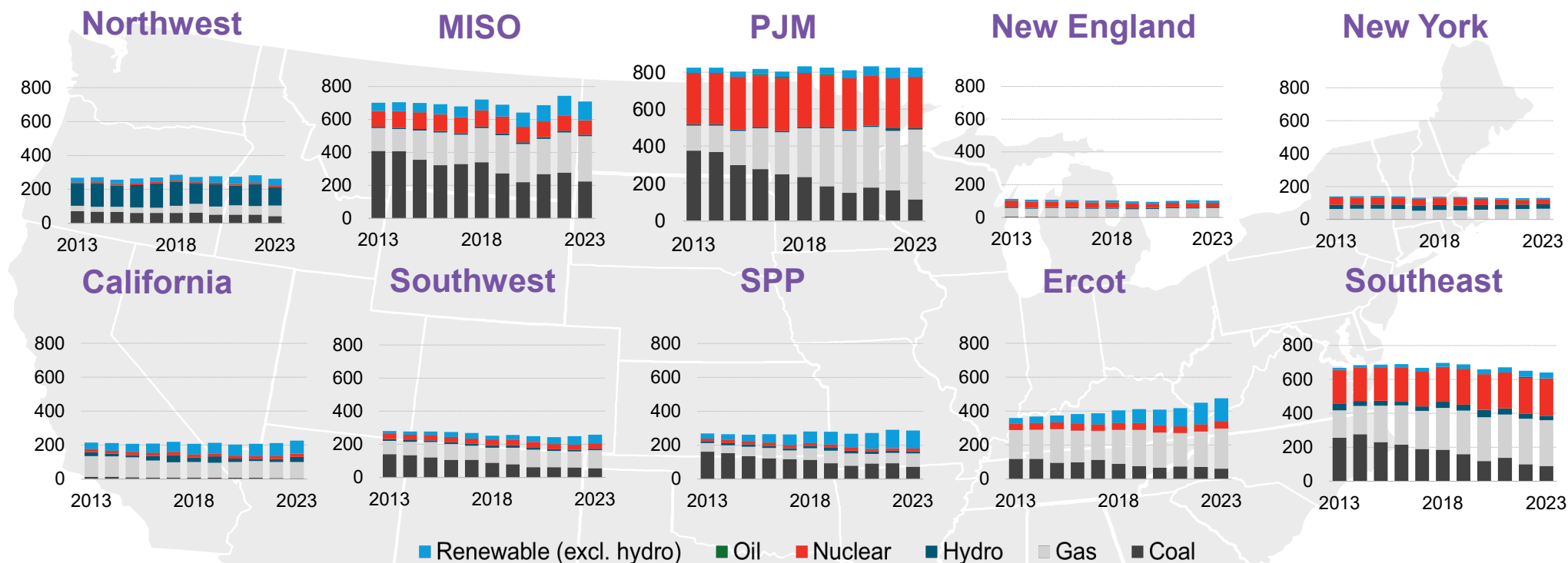
US electricity generation, by fuel type



- US power generation reached its highest volume in two decades in 2024, jumping 3.3% year-on-year to 4,393 terawatt hours (TWh). Natural gas remained the largest electricity generation source, representing 42.9% of total output in 2024. This was closely followed by zero-carbon sources, including renewables and nuclear power, which accounted for 42.0% of all electricity output.
- Renewables (including hydro) have seen the fastest growth among all power sources, in both percentage and absolute terms. In 2024, a total 1,063TWh of electricity was generated from renewables (including hydro), up 10.2% from the prior year. Nuclear generation grew 0.7% year-on-year, to reach 781TWh.
- Generation from coal dropped 4.4% year-on-year to 646TWh. In the past decade, coal-fired generation has steadily declined, from 38.5% of the generation mix to 14.7%. This gap is largely filled by natural gas and renewables, which jointly contributed 67.1% of the generation mix by the end of 2024, compared with 41.1% just a decade ago.

Source: US Energy Information Administration, BloombergNEF. Note: Values for 2024 are projected, accounting for seasonality, based on latest monthly values from US Energy Information Administration (data available through October 2024).

# US energy overview: Electricity generation mix by power market (TWh)



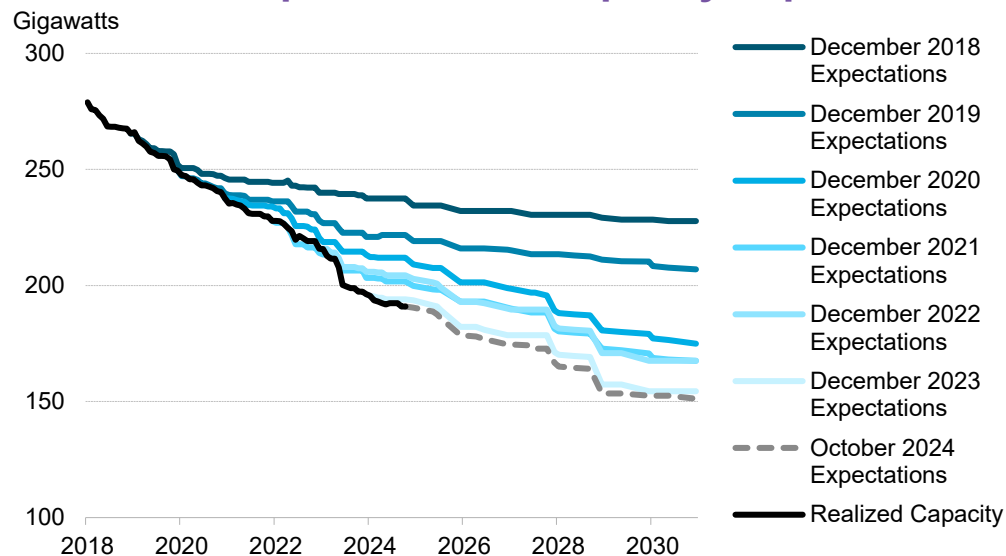
- The power generation mix varies throughout the US, with the share of fuels varying by market. Some power regions are considerably larger than others, in terms of generation. Power can also be sold between regions, but interregional trading is limited by transmission capacity across markets. About two-thirds of US power generation occurs in competitive wholesale markets.
- The major trend over the last decade continues to be the rise of natural-gas-fired generation displacing coal. For 2023, the last year for which there is sufficiently complete regional data, coal generation dropped in most regions, falling 19% year-on-year and 57% over the preceding decade.
- Renewables – primarily wind and solar – continue to grow across markets. In the Electric Reliability Council of Texas (Ercot), for example, renewable generation increased 8% year-over-year in 2023, driven primarily by solar.

Source: US Energy Information Administration, BloombergNEF. Notes: MISO (Midcontinent Independent System Operator) is the Midwest region; PJM (PJM Interconnection) is the Mid-Atlantic region; SPP (Southwest Power Pool) covers the central southern US; Ercot (Electric Reliability Council of Texas) covers most of Texas.

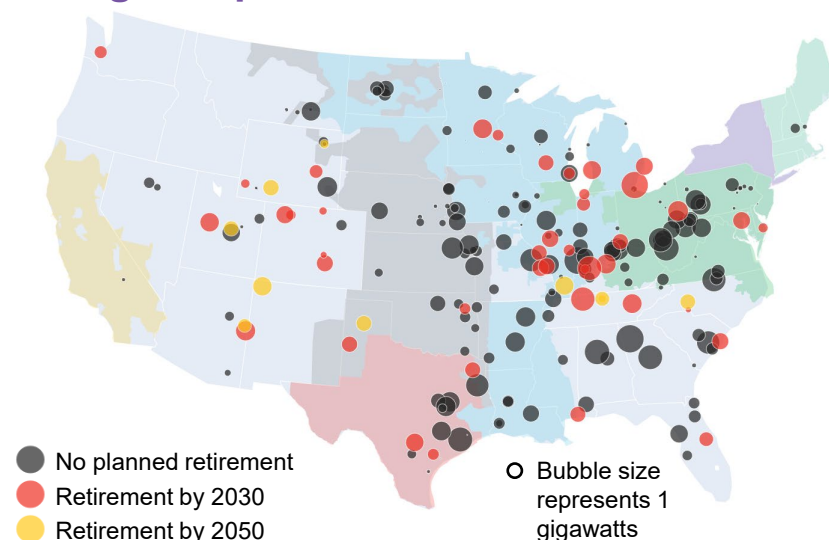


# US energy overview: Trends in coal retirement expectations

## Realized and planned coal capacity expectations



## Operating and planned coal retirements

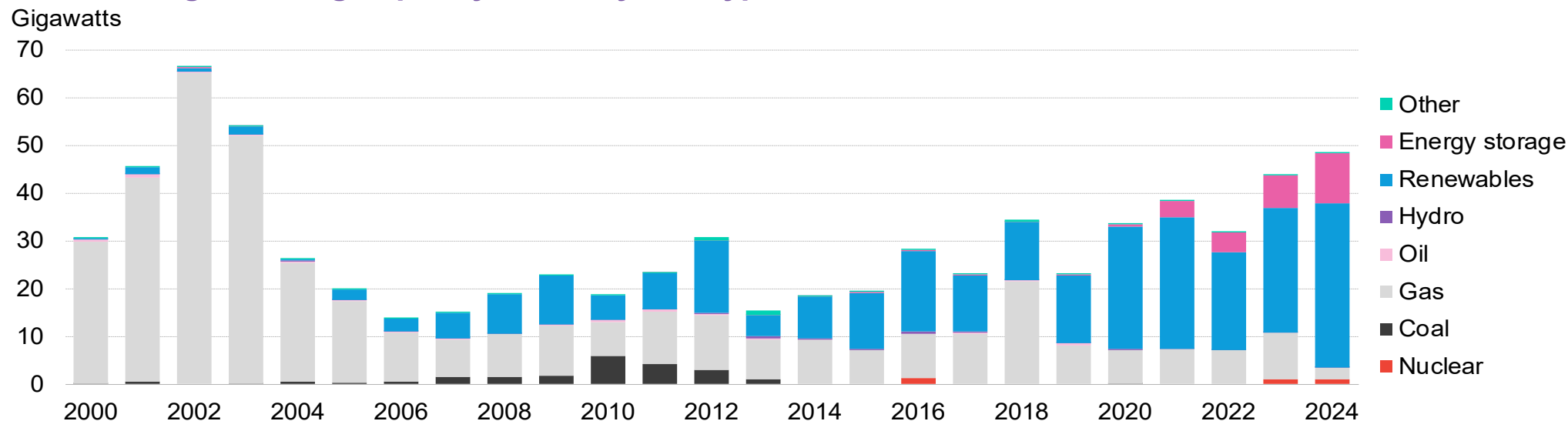


- Operational US coal capacity has been steadily declining over the last few years. From January 2018 to October 2024, operational coal capacity decreased by a total of 88.0GW. The current fleet stands at 191GW as of 2024, or 14.6% of the country's capacity.
- Plans by power plant operators to retire facilities, reported by the US Energy Information Administration (EIA), show another 40GW lined up to retire by 2030, which would shrink the US coal fleet to 151GW by the end of the decade. Historic trends suggest more coal retires than owners initially project – for example, in 2019, US Energy Information Administration data suggested that from January 2020 to December 2022, 9.5GW would retire; the period ultimately saw 30GW of coal plants shuttered.
- In 2024, however, the persistently bearish narrative defining the US coal fleet faltered, as industrial electrification and anticipated new sources of power demand (data centers) made firm dispatchable electricity a priority across the country. Supply from dispatchable thermal plants – primarily coal and gas – is now valued more than in previous years, and system operators like PJM Interconnection, Ercot and the Midcontinental Independent System Operator (MISO) seem keen to keep coal plants online for longer.

Source: US Energy Information Administration, BloombergNEF. Note: Map figure and 2024 expectations use October US Energy Information Administration data. Prior year expectations use December Energy Information Administration data.

# US energy overview: Electric generating capacity build, by fuel type

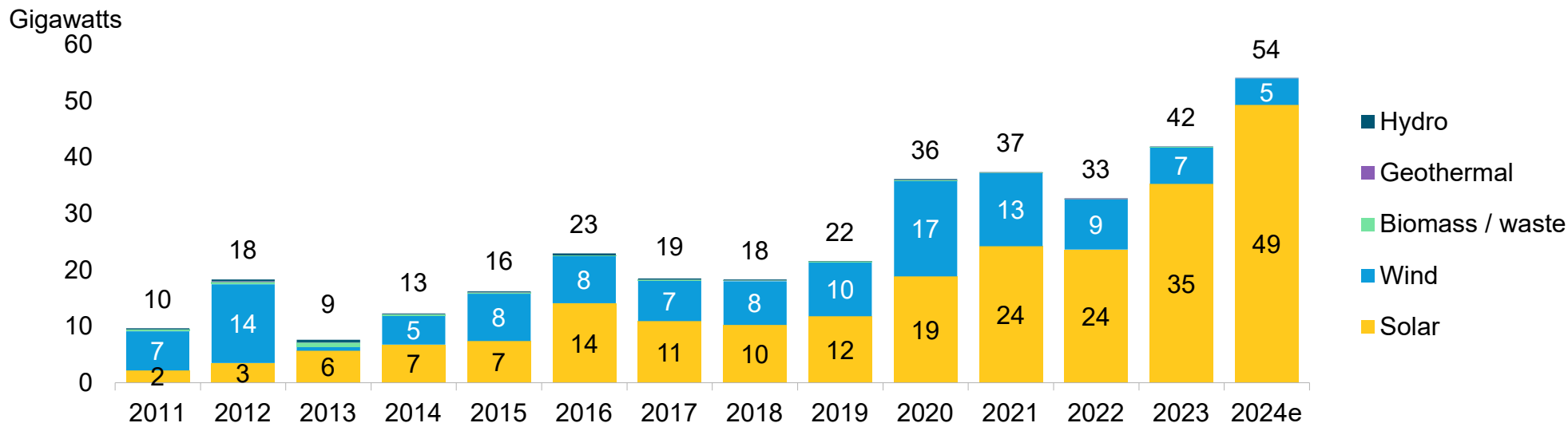
## US electric generating capacity build, by fuel type



- The US commissioned 48.4GW of new utility-scale power generating and storage capacity in 2024 – the highest annual capacity additions since 2003. Wind and solar accounted for 71%, or 34.4GW, of this expansion. Renewable generation sources grew 32% year-on-year, becoming the largest category of new additions in 2024. While renewable capacity additions have been dominated by wind and solar, new sources of generation are on the horizon; in 2024, Fervo Energy signed an agreement to deliver 320 megawatts (MW) of geothermal power to a southern California utility, with the first phase due in 2026.
- Natural gas capacity additions decreased significantly year-on-year, adding 2.4GW – the lowest volume of new additions since 2000 – even as the US needs new power generation to support load growth in the US power system. On the other hand, energy storage experienced substantial growth, adding a record 10.4GW of new utility-scale capacity in 2024. This marks a 51% increase from the previous year, highlighting a strong shift toward clean and dispatchable power technologies.
- Additionally, after the Vogtle Unit 3 nuclear generator began operations in 2023, Vogtle Unit 4 came online in April 2024 in the Southeast power region, adding 1.1GW of clean firm capacity to the grid.

Source: US Energy Information Administration (eia), BloombergNEF. Note: Historical and 2024 thermal and hydro capacity figures use EIA survey data. Note: Solar capacity counted in alternating current (AC) terms to enable a comparison to other grid-facing technology. Distributed rooftop solar not included.

# US energy overview: Renewable energy capacity build by technology

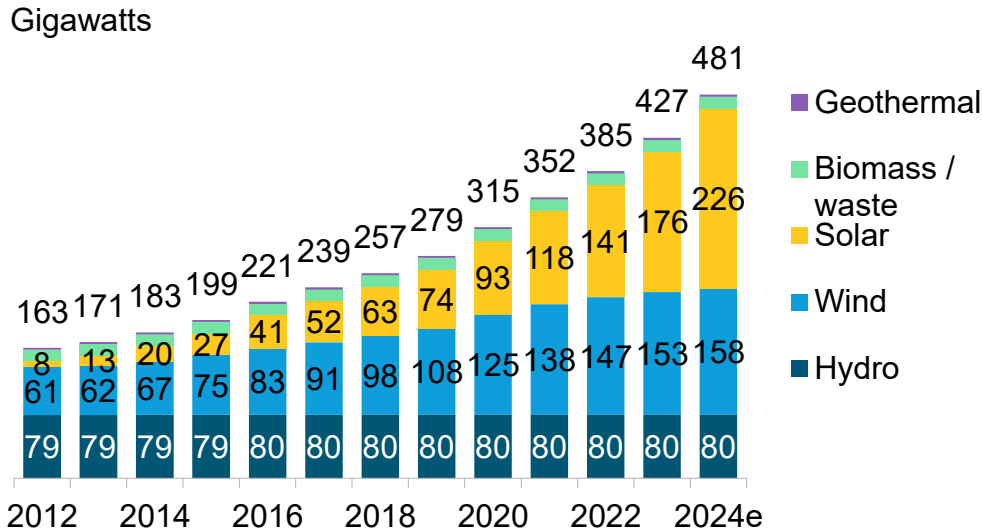


- A total of 54GW of renewable capacity came online in 2024, up 29% from 2023, driven by record levels of solar installation. Despite the challenges around high costs of debt, constraints in site permitting, and grid connection bottlenecks, clean power deployments are propped up by steady demand for renewables from state and utility decarbonization goals, as well as appetite from corporate buyers for clean energy.
- A record 39.6GW of utility-scale solar connected to the grid last year, meeting rising demand from new data centers and electric vehicles, while also filling the supply gap caused by decommissioning thermal assets. Texas was the largest market for new utility-scale solar build, with almost 10GW of new capacity added in 2024. Nearly 10GW of rooftop solar on homes and businesses was also added in 2024.
- Annual onshore wind installations remained unchanged. Wind development activity has slowed down since 2020, largely due to permitting and grid connection constraints. In addition, power prices slump during windy periods in markets with high wind penetration, discouraging new capacity buildout in these regions.
- New biomass, geothermal and small hydro build remained comparatively small in 2024. The Beowawe geothermal power plant in Nevada, which has a capacity of 29.2MW, finished a repowering update in 2024. In 2025, Southeast Renewable Fuels expects to bring online a biomass plant of 20MW in Hendry county, Florida, while other counties are evaluating expansions of waste-to-energy facilities. Construction has begun on an 18MW expansion for the Pascoe County Commission in Florida

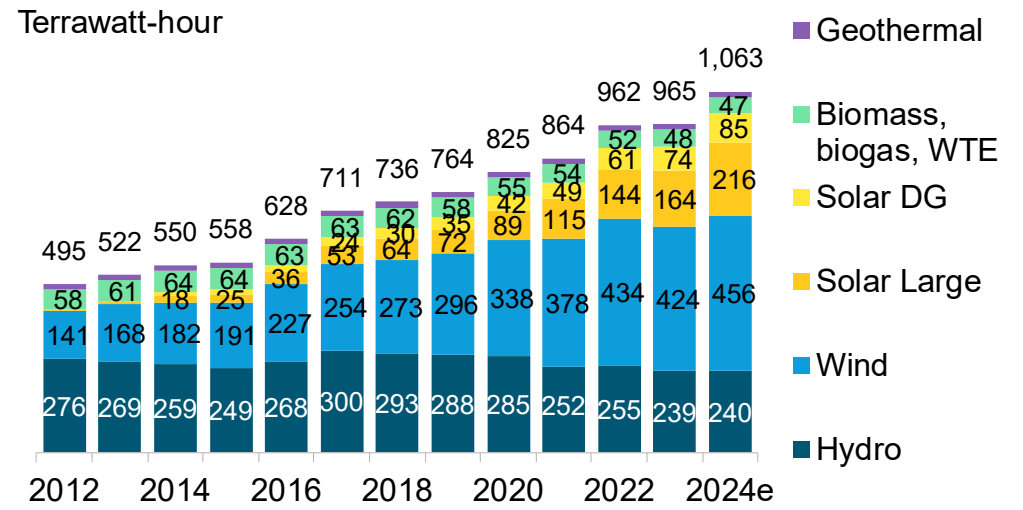
Source: BloombergNEF, [US Energy Information Administration \(EIA\)](#). Note: All values are shown in alternating current (AC) except solar, which is included as direct current (DC) capacity using a 1.34 conversion factor. Numbers include utility-scale (>1MW) projects of all types, rooftop solar, and small- and medium-sized wind. Includes installation figures from the US EIA through December 2024

# US energy overview: Cumulative renewable energy

## US cumulative renewable power capacity



## US renewable generation, by technology

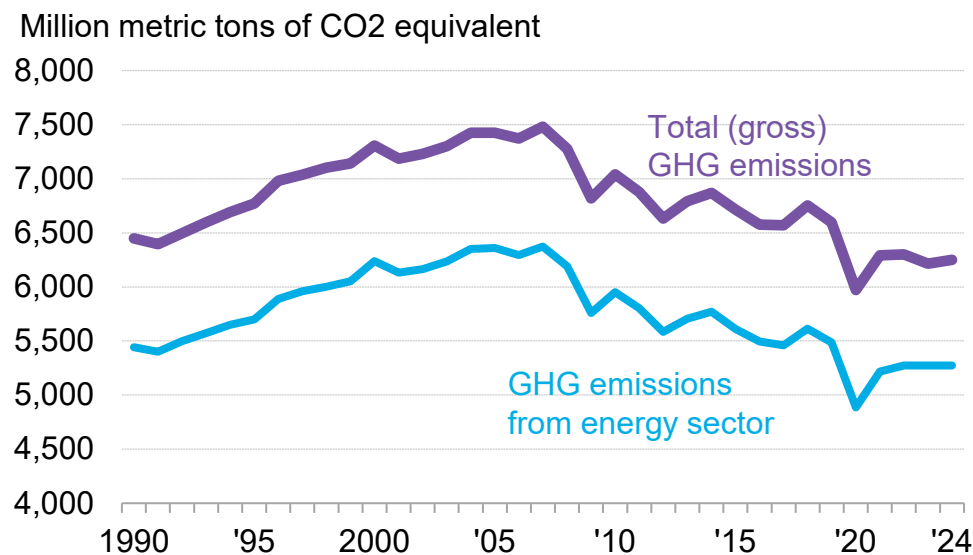


- In 2024, total US renewable energy capacity, excluding pumped hydro facilities, rose to 481GW, up 12.7% from the prior year. The growth was largely driven by rapid solar buildout, which saw a 27.9% year-on-year increase, reaching a total capacity of 226 gigawatts. While annual additions of wind capacity fell compared with 2023, the total installed US wind fleet grew 3.1% year-on-year, the second-fastest growth rate of any clean technology.
- Total renewable electricity generation in the US rose 10.2%. Power generation from utility-scale solar facilities experienced its largest year-on-year growth since 2017, rising 31.4% to 216TWh. Generation from distributed solar on residential and business rooftops grew 15%, to 85 TWh.
- Overall, wind remained the largest generating source, accounting for 43% of total renewable output. The 158GW of US wind capacity produced 456TWh of electricity in 2024, followed by hydro, which generated 240TWh. Renewable generation from combustion – biomass, biogas, waste-to-energy (WTE) - and geothermal further slipped, down 2.5% and 5.5%, respectively.

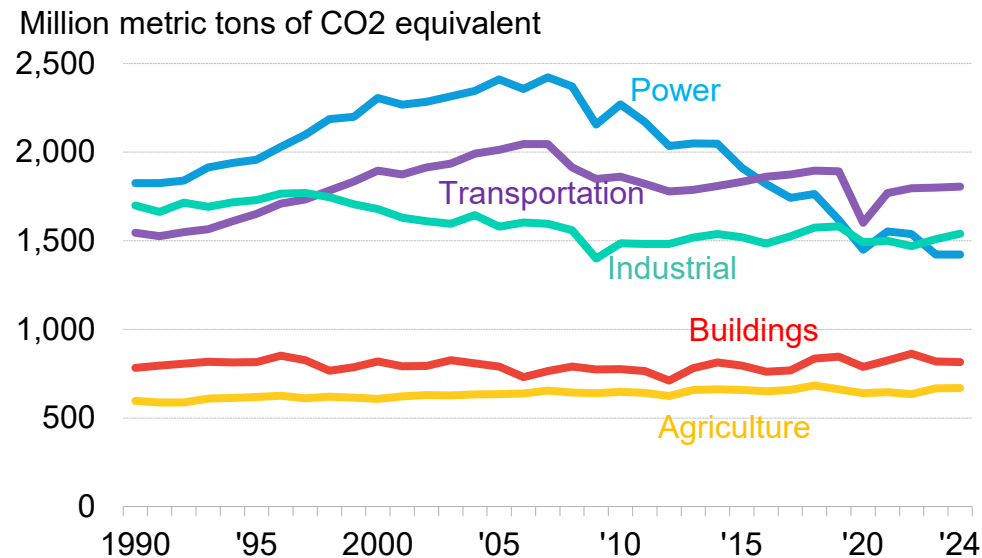
Source: BloombergNEF, US Energy Information Administration (EIA). Note: All values are shown in alternating current (AC) except solar, which is in direct current (DC) capacity using a 1.34 conversion factor. Totals may not sum due to rounding. Values for 2024 are projected, accounting for seasonality, based on latest monthly values from US EIA (data available through December 2024). WTE refers to waste-to-energy, while DG is distributed generation.

# US energy overview: Greenhouse gas emissions

## Economy-wide and energy sector emissions



## Emissions by sector



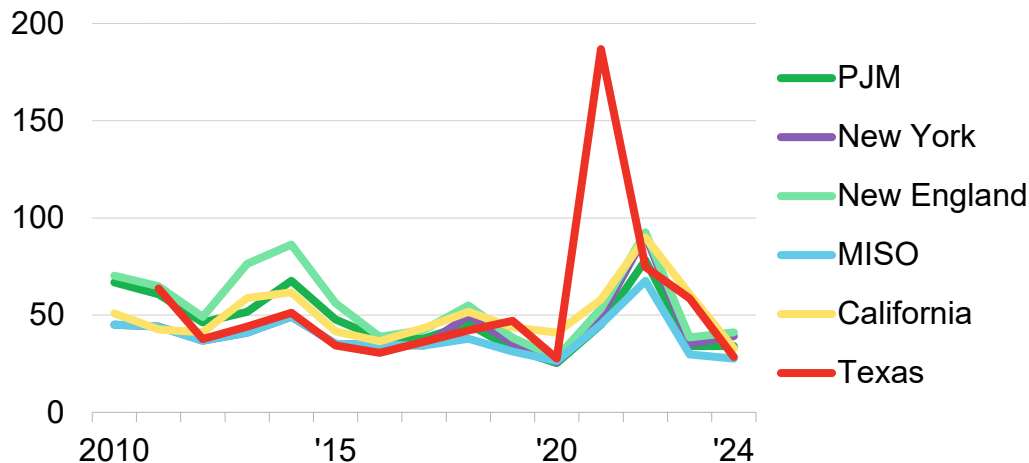
- The US emitted 6,250 million metric tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) last year, according to BNEF estimates, a 0.5% increase over 2023. Emissions rose in industry, transport and agriculture, which more than offset the slight decline in emissions from building energy use. Industrial emissions have grown 2.7% and 2% in 2023 and 2024 respectively, largely due to increased natural gas use. In 2024, the growth in industrial emissions represented 89% of the country's total emissions growth. Emissions from power generation were unchanged year-on-year.
- Transport accounts for more emissions than any other sector of the US economy. Industry is second, narrowly edging out emissions from power over the past two years. While transport emissions have fallen by 0.3% over the past decade, they have risen 0.3% year-on-year; the sector's emissions appear to have stabilized, suggesting more work is needed to bring them down.
- Total US emissions have fallen by 9% over the past decade, and 16.5% since their 2007 peak. Most of the gains have come from the steady displacement of coal in the power system by natural gas. Outside of power, steady emissions cuts have been harder to sustain.

Source: BloombergNEF, US Energy Information Administration, US Environmental Protection Agency. Note: GHG stands for greenhouse gas.

# US energy overview: Retail and wholesale power prices

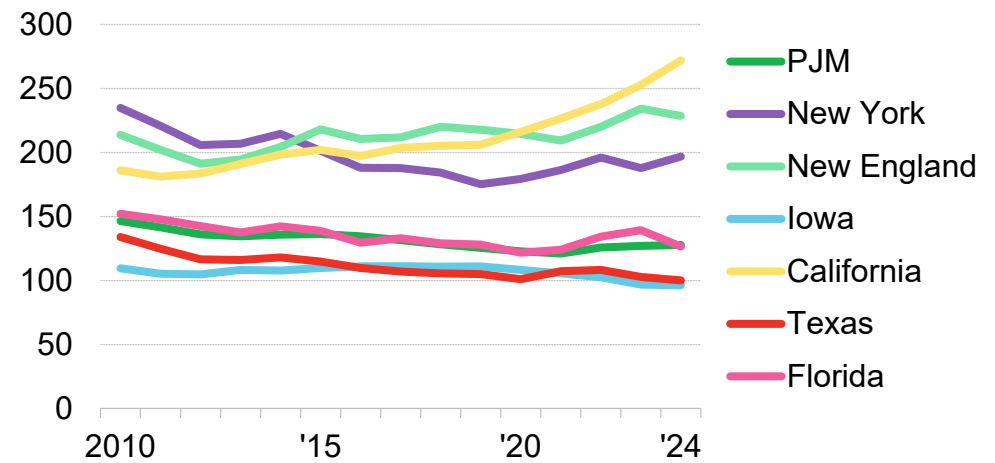
## Wholesale power prices

\$ per megawatt-hour (real 2024)



## Retail power prices

\$ per megawatt-hour (real 2024)



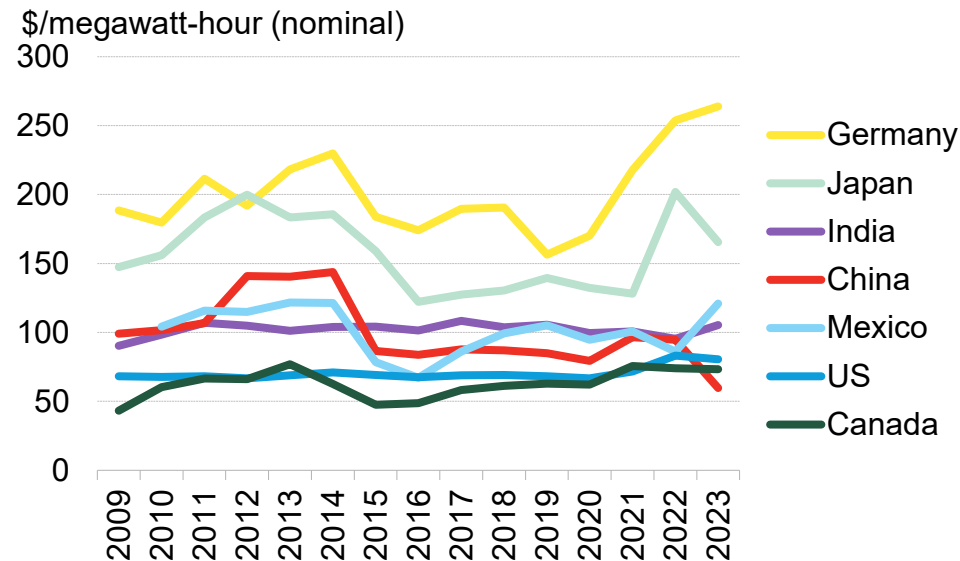
- Electricity markets in 2024 highlight a growing divide, with regional dynamics driving stark differences in power prices. Wholesale prices were stable nationally, rising by just 0.1% year-on-year. Yet beneath this calm, regional shifts tell a more complex story: California and Texas saw wholesale prices plummet by 45.9% and 51.4%, thanks to high renewable output, while New York and New England experienced increases of 11.1% and 6.1%, driven by reliance on natural gas and constrained supply.
- Retail prices, less reactive to short-term wholesale changes, fell modestly by 0.68% on average in 2024. Regional differences, however, remain stark. Texas and New England saw retail price drops of 2.5% and 2.4%, while California and New York experienced increases of 7.6% and 4.8%, reflecting higher transmission and distribution costs.
- While wholesale prices are driven by trends related to the underlying resource mix, commodity prices and state policy, retail prices include the costs of fixed investments into infrastructure – the poles and wires – that deliver electricity to customers. California exemplifies where these metrics diverge: in 2024, wholesale power prices fell in line with falling natural gas prices, but retail prices maintained their year-on-year rise as customers pay for the fixed costs of delivering power to them in addition to the cost of producing power.

Source: BloombergNEF, US Energy Information Agency, Bloomberg Terminal. Note: Wholesale prices are taken from proxy power hubs in each independent system operator (ISO). All prices are in real 2024 USD. Retail power prices shown here are not exact retail rates but weighted averages across all rate classes by state, as published by the US Energy Information Administration. Retail prices are updated through September 2024. MISO is the Midwest region; PJM is the Mid-Atlantic region.

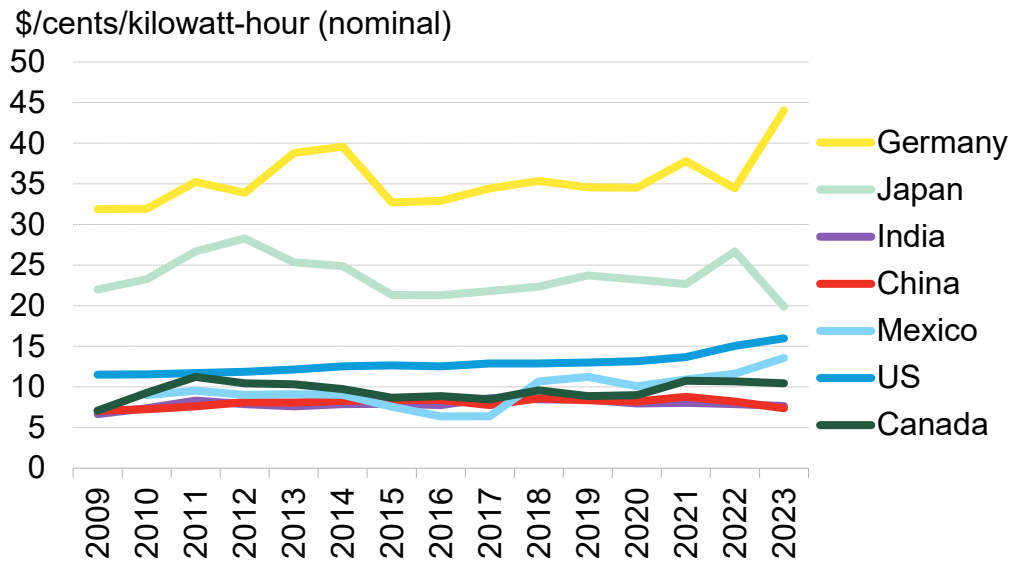


# US energy overview: Average electricity rates, by country

## Industrial power prices



## Residential power prices

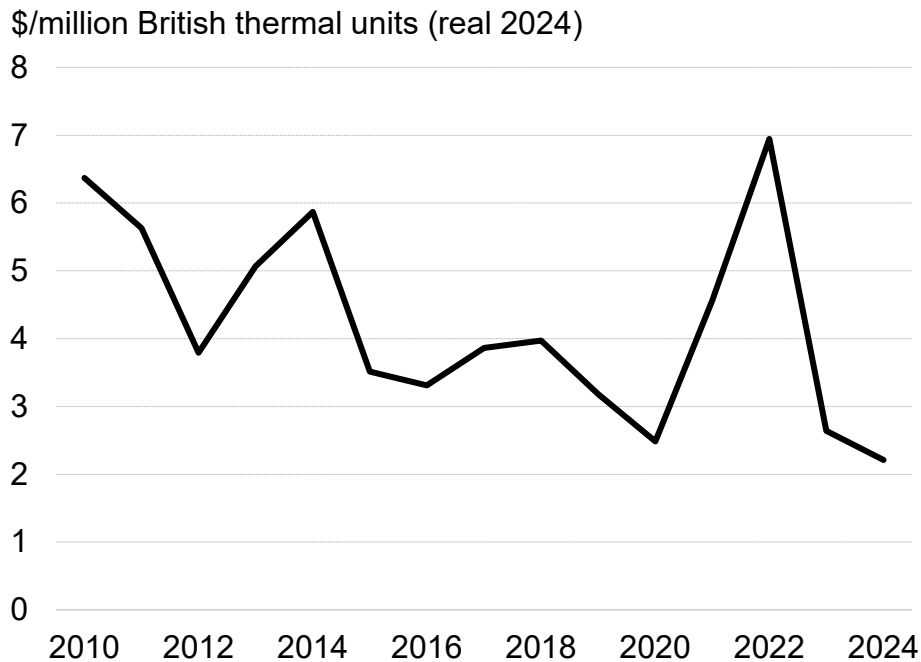


- Industrial power prices in the US remained low in comparison to other G-7 nations. In 2023, the last year for which there is complete data, only China and Canada saw prices lower than the US.
- While underlying factors like higher fuel prices drive some of the directional shift, the impact of exchange rates also plays a role. For example, industrial prices fell slightly year-on-year in Japan, but the currency's weakness against the dollar makes the drop appear steeper in charts that compare prices using a common currency base. In 2023, the Chinese yuan, Indian rupee, and Japanese yen weakened against the dollar on average compared to 2022.
- Average residential power prices in the US rose 6% year-on-year in 2023, to 16 cents per kilowatt-hour (c/kWh), with only Japan and Germany reporting higher power costs for household use. German power prices continue to feel the impact of the war in Ukraine, as residential power prices rose to 44c/kWh from 34c/kWh in 2022. India, China, Japan and Canada saw residential prices fall year-on-year. Over the decade to 2023, US residential prices rose 32%; only China and Japan saw decadal price declines in this period, of 9% and 21% respectively.

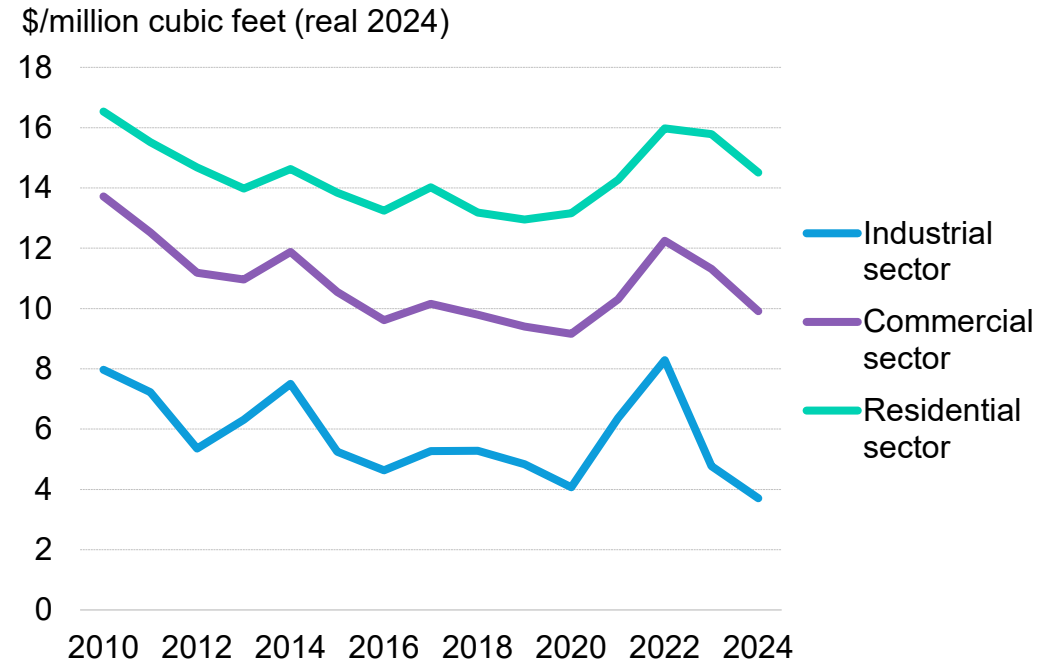
Source: BloombergNEF, government sources (US Energy Information Administration for the US). Note: Prices are averages (and in most cases, weighted averages) across all regions within the country. Japanese data are for the commercial and industrial (C&I) segment, and 2016 figures come from a different source than preceding years.

# US energy overview: US natural gas pricing, wholesale and by end use

## Natural gas wholesale prices at Henry Hub, LA



## Natural gas prices to end users, US average

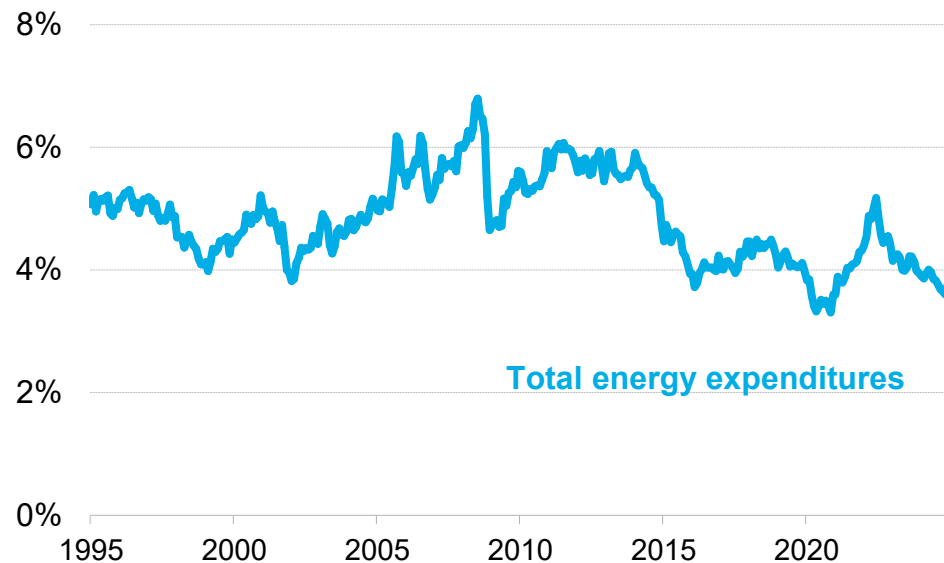


- The US saw natural gas prices fall at Henry Hub for the second year in a row. Wholesale prices fell 16% below 2023 figures in real terms, driven by high storage levels following a mild winter in 2023-24, along with steady growth in US gas production.
- Prices for end users in all retail segments fell across the board as well. Industrial, commercial and residential natural gas prices fell 22%, 12%, and 8%, respectively.
- Residential price adjustments tend to lag index prices by six to 12 months, depending on utility practices, while industrial prices tend to be most correlated to wholesale markets. This dynamic is part of the significantly lower decline observed in residential prices compared to industrial prices.

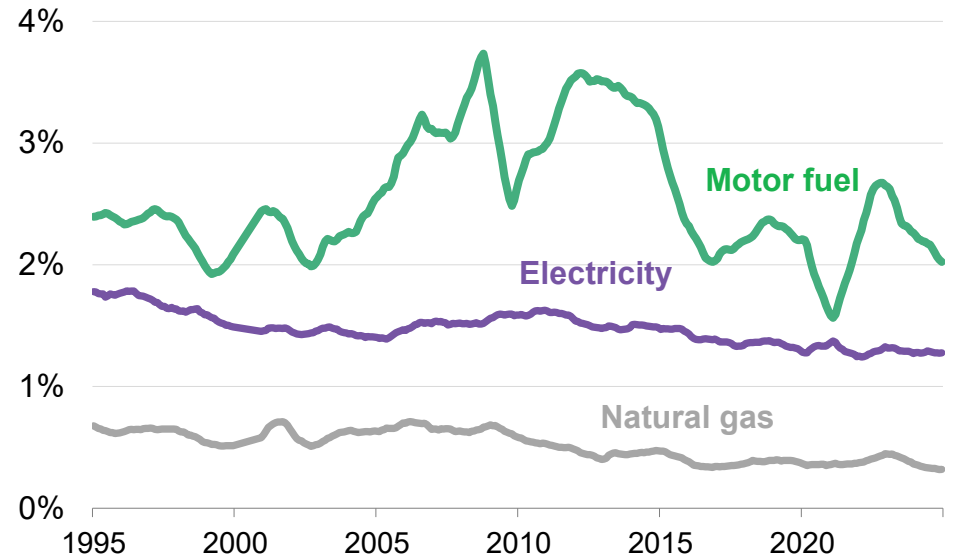
Source: BloombergNEF, US Energy Information Administration Short Term Energy Outlook.

# US energy overview: Energy as a share of personal consumption expenditures

## Total energy goods and services as share of total consumption expenditure



## Components of total consumption expenditure, 12-month rolling average

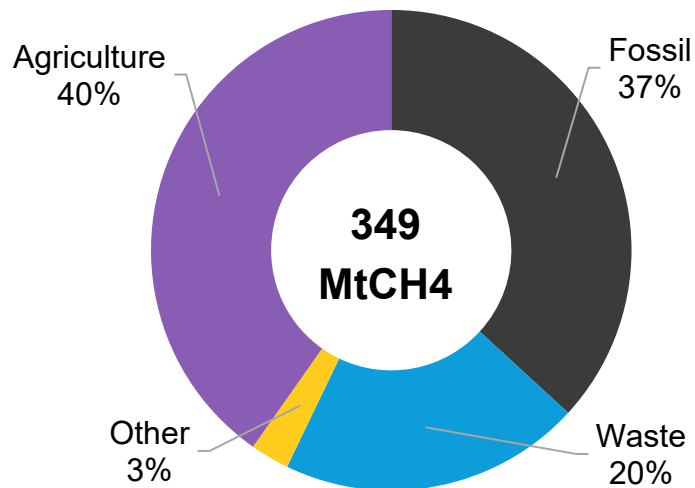


- Total energy expenditure as a share of personal consumption expenditure, including all energy goods and services, fell year-on-year in 2024. Energy spending accounted for 3.82% of total US personal consumption expenditures, down 0.3 percentage point from 2023.
- The share of motor fuel in personal expenditures dropped to 2% in 2024, down 0.24 percentage points from the year before, reflecting lower gasoline prices. While gasoline prices fluctuated over the course of the year, 2024 prices were lower than in 2023 on average.
- The combined share of electricity and gas cost as part of total household expenditure fell to 1.60%, from 1.64% in 2023. This follows trends in natural gas prices falling year-on-year, which translated to lower retail prices for consumers, as well as some movement in power prices. While retail power prices across the country vary by region, US consumers in 2024, on average, spent slightly less on electricity than during the year prior.

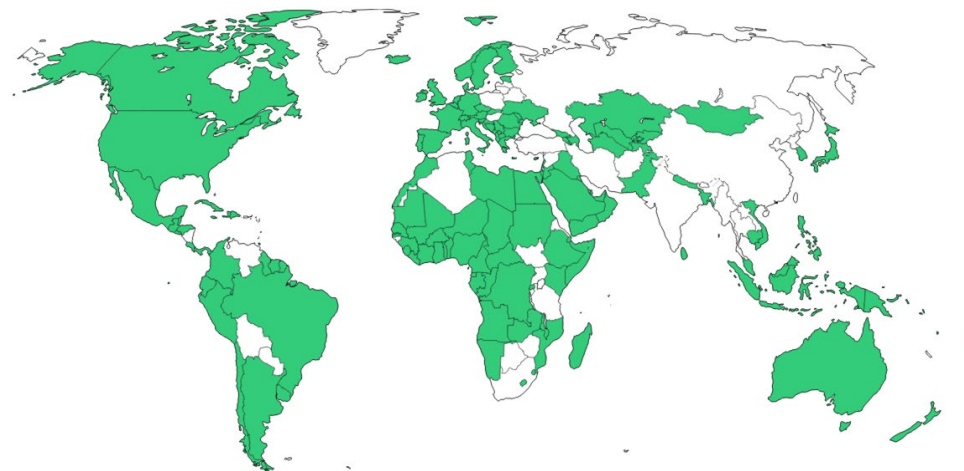
Source: Bureau of Economic Analysis "Table 2.4.5U. Personal Consumption Expenditures by Type of Product", BloombergNEF.

# US energy overview: Methane emissions

## Global 2023 methane emissions by sector



## Markets participating in the Global Methane Pledge

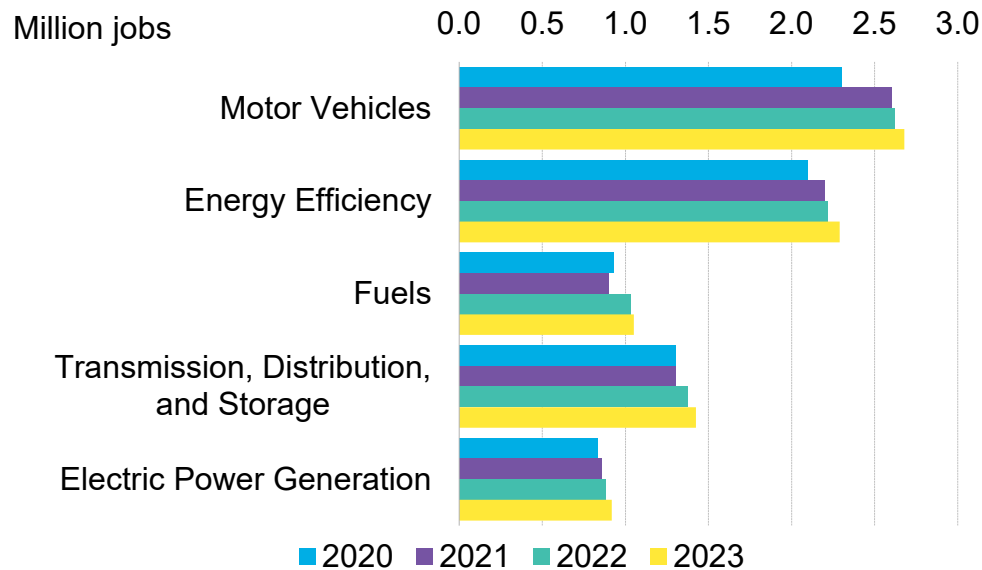


- Methane (CH<sub>4</sub>) is the main component of natural gas and accounts for 11.5% of all greenhouse gases, second only to CO<sub>2</sub>, according to the Intergovernmental Panel for Climate Change (IPCC). Over a 100-year time horizon, one kilogram of methane has a global warming potential of approximately 29.8, meaning it produces the same cumulative radiative forcing as 29.8 kilograms of CO<sub>2</sub>.
- Methane concentrations have been increasing globally over the past four decades, with the largest year-on-year increases between 2018 and 2022. According to data compiled by the International Energy Agency (IEA), methane emissions from fossil fuels rose by 3% globally in 2023, compared to the previous year. Emissions from other sectors such as agriculture and waste remained in line with 2022 levels.
- High-resolution satellites such as Carbon Mapper's Tanager-1 and the Environmental Defense Fund's MethaneSat, both launched in 2024, will improve methane emissions observations. In the US alone, existing satellites recorded 299 releases of methane exceeding 100 kilograms per hour from oil and gas infrastructure between January 2023 and April 2024.
- A total of 159 markets are now participating in the Global Methane Pledge, up by four from the previous year. The pledge involves committing to take actions to help reduce global methane emissions at least 30% from 2020 levels by 2030. Participants include major markets such as the US, the UK, Brazil and Japan, as well as major emitters like Turkmenistan.

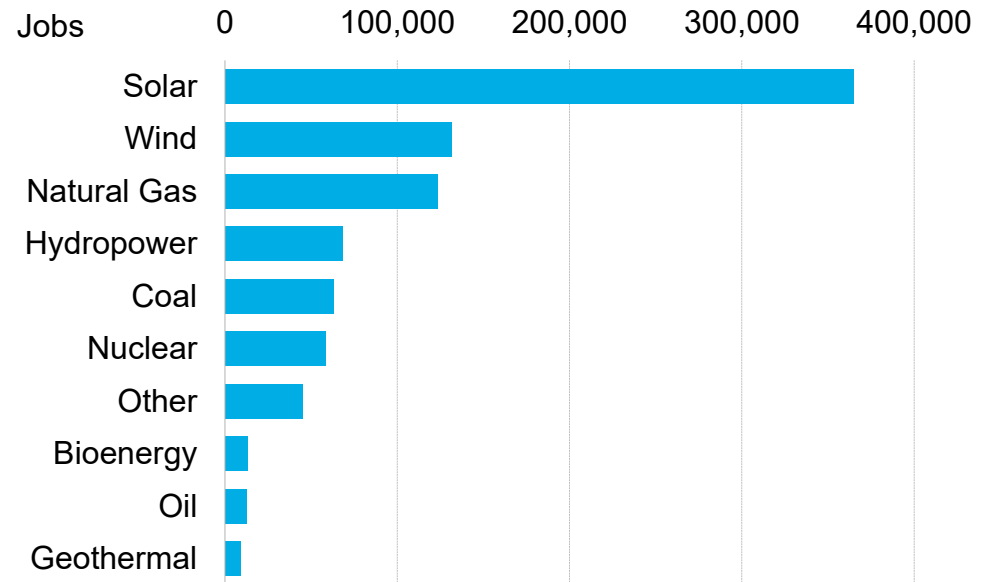
Source: BloombergNEF, International Energy Agency (IEA) Methane Tracker, Global Methane Pledge. Note: MtCH4 is million metric tons of methane. Green-shaded markets in the map above are participating in the Global Methane Pledge; white-shaded markets are not.

# US energy overview: Jobs in select segments of the energy sector

## Jobs in select energy segments, 2020-23



## Jobs by power-generating technology, 2023



- The total number of workers employed in the energy sector grew by 3%, to roughly 8.36 million in 2023, the last year for which there is complete data, according to an annual US Department of Energy report.
- Motor vehicles and component parts, a category that covers manufacturing, trade of, and maintenance work on vehicles, employed the most people, at 2.7 million. The segment has also seen the most growth over the last four years, growing 16.4% since 2020. The fuels sector, representing jobs in mining and extraction of coal, oil and gas, as well as renewable fuels production, grew the second-fastest, by 13% since 2020.
- Among power-generating technologies, solar continues to represent the largest share of total jobs, accounting for 41% of power-sector employment. Coal is the only segment that has seen a year-on-year decrease in employment opportunities, down 1% from the prior year. The bioenergy segment saw employment opportunities stagnate.

Source: US Department of Energy's [2024 Energy & Employment Report](#), BloombergNEF.

# Table of contents

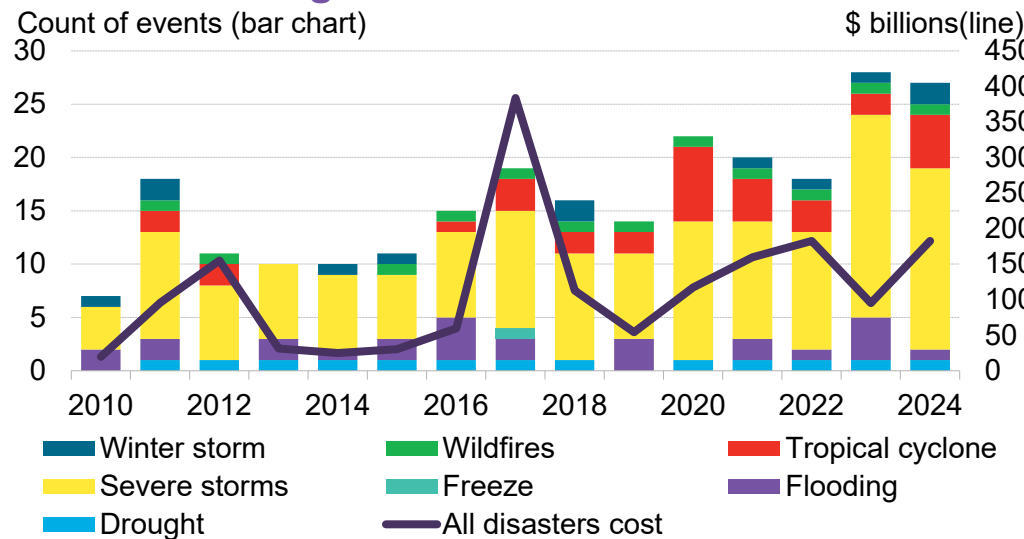


<u>1. Executive summary</u>		
<u>2. A look across the US energy sector</u>		
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>
	<u>3.2 Tax credits and stimulus</u>	
	<u>3.3 Vehicle standards</u>	
<u>4.1 Energy transition investment</u>	<u>7. Transportation</u>	
<u>4.2 Utility investment</u>		
<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>
	<u>5.2 Environmental markets</u>	<u>6.2 Natural gas</u>
		<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>
		<u>6.5 Hydrogen</u>
		<u>7.1 Gasoline</u>
		<u>7.2 Fuel prices and EV sales</u>
		<u>7.3 Renewable natural gas</u>

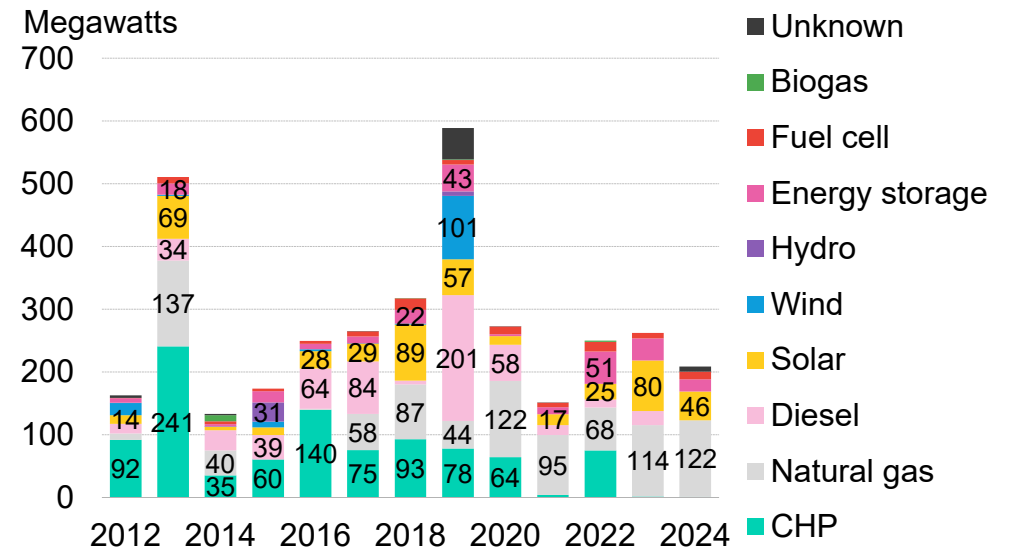


# Policy: Infrastructure and resilience

## Weather events in the US causing at least \$1 billion in damages



## US microgrid installed capacity, by technology

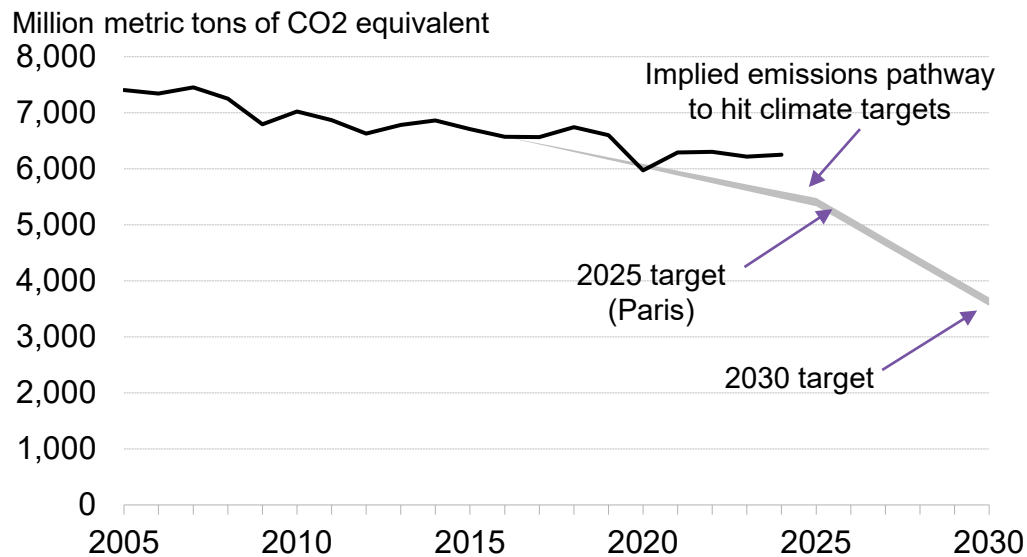


- The US experienced 27 climate disasters that together caused \$182.7 billion in damages in 2024. While the number of events was slightly lower than during the previous year, it is the second-highest count for natural disasters since 2010, and the total cost associated with these events was almost double the year before. This higher cost is largely the result of five destructive tropical cyclones. Since 2017, tropical cyclones have been the most costly type of natural disaster, with losses in 2024 totaling \$124 billion, or 68% of the year's total disaster costs.
- Early indications suggest that 2025 will be expensive for climate disasters. Wildfires in California in January burned through areas of Los Angeles that have high property values, although data on insurance claims is forthcoming.
- Last year, 59 new microgrids sized 241MW altogether were brought online to ensure resiliency in the case of grid outages. Natural gas powered 122MW, or about half of this capacity, largely driven by two large systems built for resiliency at a Houston water treatment plant, and the Turlock Irrigation District respectively. Some 46MW of solar and 12MW of fuel cells were also brought online as part of microgrids across the country. Energy storage volumes were lower than the last two years, with 19.5MW of storage (33.2 megawatt-hours in in energy capacity terms) brought online in 2024.

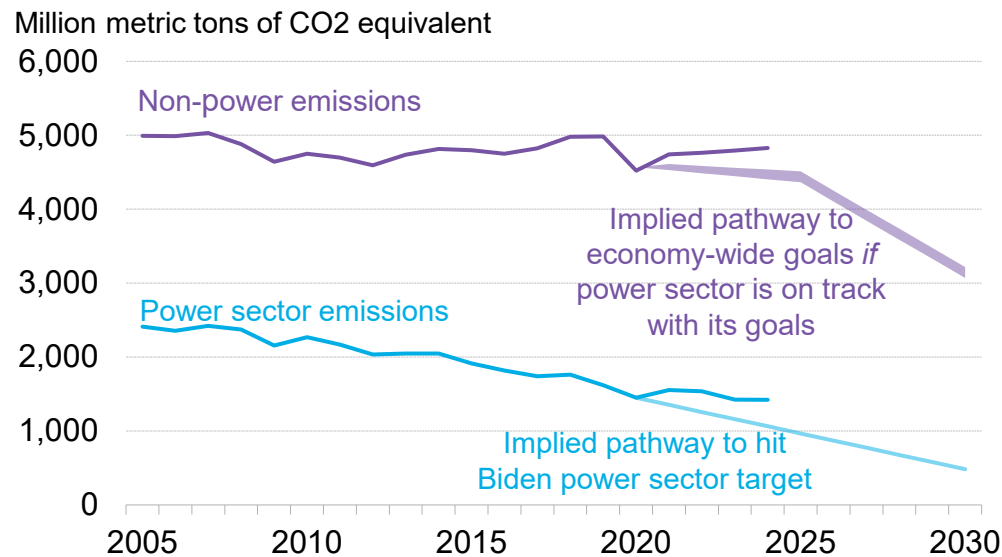
Source: National Oceanic and Atmospheric Administration, BloombergNEF, US Department of Energy, ICF. Note: Chart portrays annual counts of drought, flooding, freeze, severe storm, tropical cyclone, wildfire and winter storm events in the US with losses of more than \$1 billion each. CHP stands for combined heat and power.

# Policy: US progress toward emissions goals

## US economy-wide emissions



## US power emissions

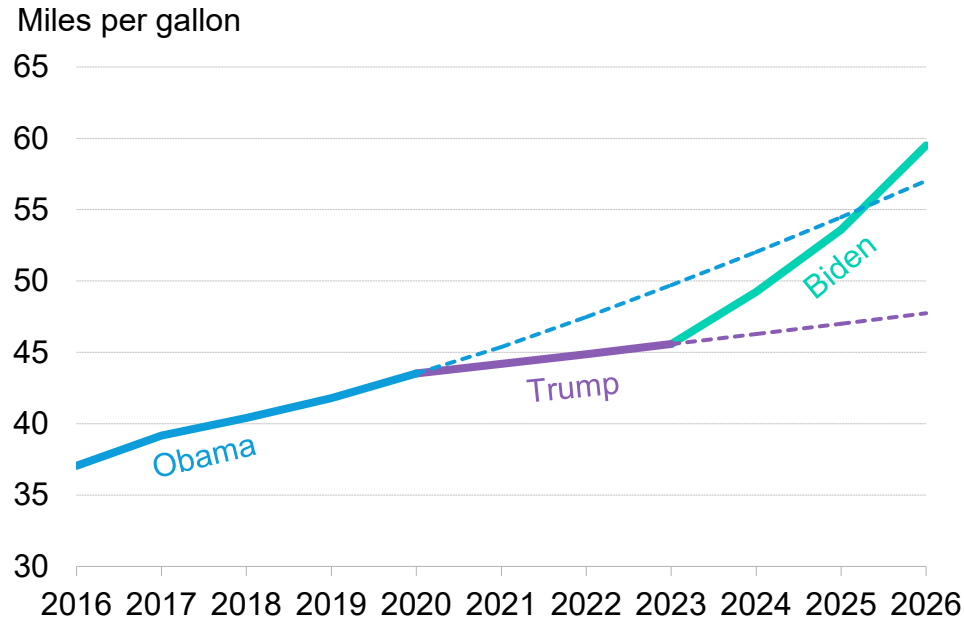


- The US withdrew from the Paris Agreement in January 2025. However, targets that had been in place most of 2024 required the US to cut emissions by 50-52% from 2005 levels by 2030 under the framework of the Paris Agreement. That followed the original Paris pledge made under the Obama administration of reducing emissions by 26-28% below 2005 levels by 2025.
- Following the 2024 rise in emissions, the US is off track from these targets. While emissions from the broader economy have reduced steadily, most of these gains are due to the power sector switching from coal to gas, and these declines carry the country's total progress. Outside the power sector, emissions have stagnated, with all other sectors falling only 4% since the country's peak in 2007; over the past decade, non-power emissions grew 0.24%.
- For the US to remain on track for its post-2025 goals, power emissions need to fall by 11% each year, compared to no change observed in 2024. For the rest of the economy, emissions need to fall at an annual rate of 6% through 2030, a large shift compared with the 0.7% rise observed in 2024.

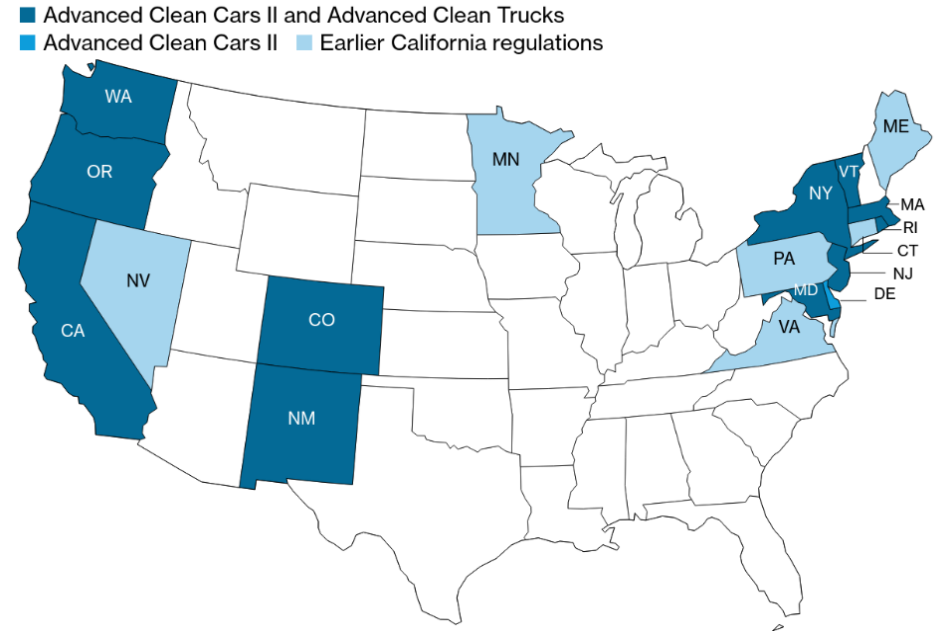
Source: US Energy Information Administration, Environmental Protection Agency, BloombergNEF.

# Policy: EV adoption hinges on federal and state level policy shifts

## Fuel economy targets for passenger cars under different administrations



## States that have adopted California's vehicle regulations



- Fuel economy standards are one of the policy levers by which vehicle manufacturers are encouraged to roll out more energy efficient models, including electric vehicles which consume less energy per mile than their internal combustion engine equivalents.
- In 2024, the Biden administration finalized the second set of fuel economy targets for model years (MY) 2027-2032, following the MY 2022-26 rules that were set during the 2021-22 congressional term. The incoming administration has announced intentions to loosen these standards. Weakening of the fuel economy standards would remove a major incentive for automakers to introduce new EV models.
- California has an outsized influence on the US electric vehicle market by providing an alternative option to federal standards. As of 2024, 17 states and the District of Columbia have adopted at least some of California's vehicle emissions standards, collectively accounting for 40% of new light-duty vehicle registrations and 26% of heavy-duty vehicle registrations in the US.

Source: BloombergNEF, US Environmental Protection Agency, US National Highway Traffic Safety Administration (NHTSA), California Air Resources Board. Note: Dotted lines indicate targets that have been replaced by the next administration. Biden targets refer to 2022-26 final rule.

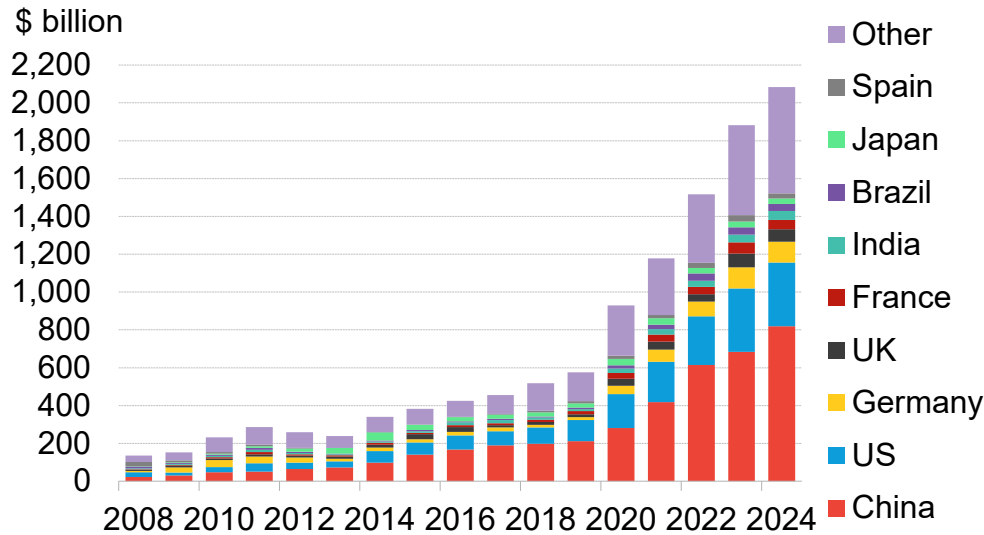
# Table of contents



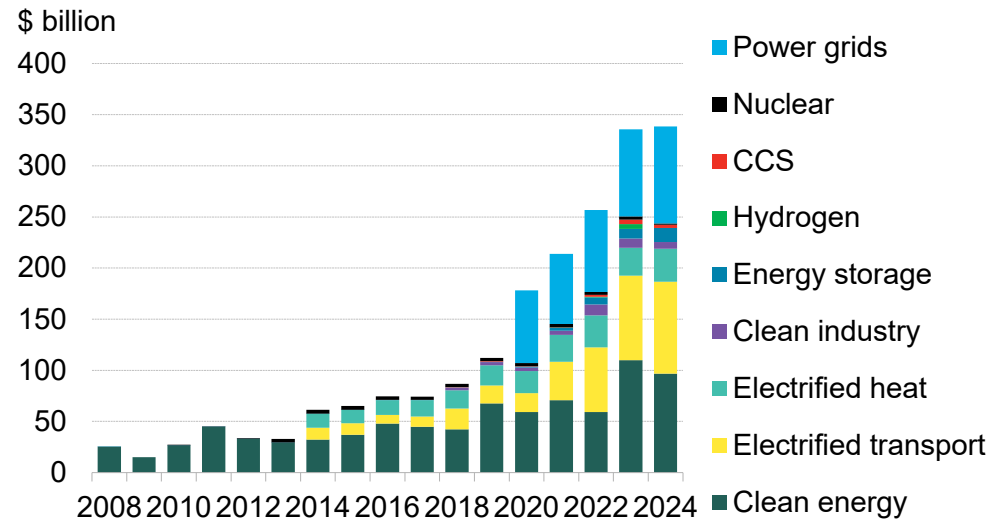
<u>1. Executive summary</u>		
<u>2. A look across the US energy sector</u>		
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>
	<u>3.2 Tax credits and stimulus</u>	
	<u>3.3 Vehicle standards</u>	
<u>4.1 Energy transition investment</u>	<u>7. Transportation</u>	
<u>4.2 Utility investment</u>		
<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	
	<u>5.2 Environmental markets</u>	
		<u>6.1 Energy efficiency</u>
		<u>6.2 Natural gas</u>
		<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>
		<u>6.5 Hydrogen</u>
		<u>7.1 Gasoline</u>
		<u>7.2 Fuel prices and EV sales</u>
		<u>7.3 Renewable natural gas</u>

# Finance: Energy transition investment

## Energy transition investment, by market



## US energy transition investment, by sector

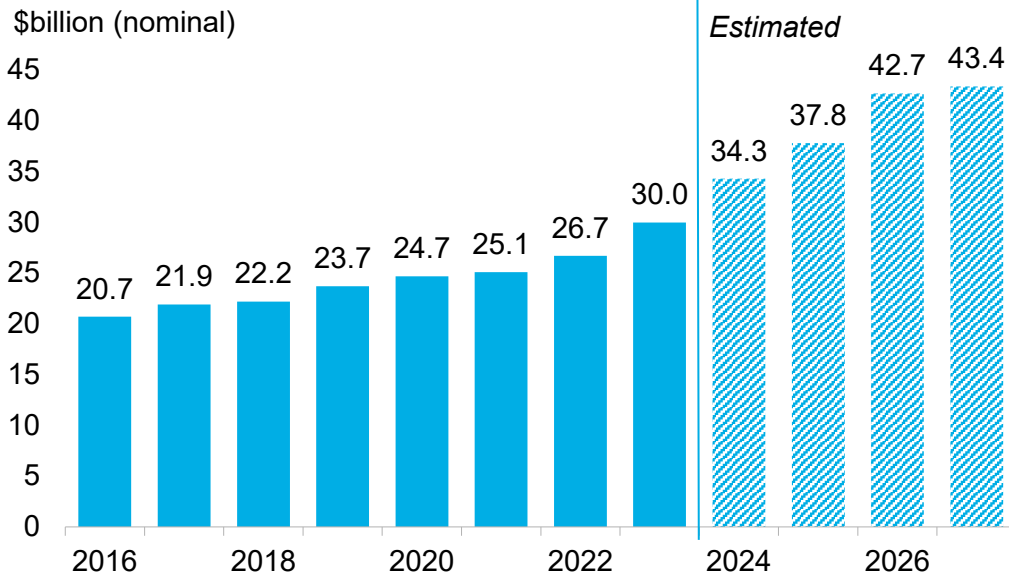


- Just over \$2 trillion was spent globally in 2024 on technologies that are accelerating the decarbonization of the global economy. China continues to invest more than any other market, accounting for \$818 billion of the funds deployed. That's equivalent to 4.4% of China's estimated 2024 GDP, up 0.58 percentage points from the prior year. US energy transition investment was 1.2% of 2024 GDP, a drop from 2023.
- Despite a slowdown in spending, the US remained the country with the second-largest investment in the energy transition, growing 0.8% year-on-year in 2024 to hit \$338 billion. Clean energy investments saw a 12% drop in investment compared with 2023, but they still drew the most funding, followed by grid buildout. Together with electrified transport, these sectors drew 83% of US energy transition spend in 2024.
- Across sectors, investment in energy storage expanded the fastest, up 46.4% from the prior year, followed by rapid growth in electrified heat, which increased by 28.2% during the same period. Hydrogen investments suffered the steepest drop, falling by 95% to \$0.2 billion in 2024 – a reflection of policy uncertainty weighing on a nascent market. Investments in nuclear and clean industry, which include clean ammonia and steel, also declined by 52.2% and 25.5%, respectively.

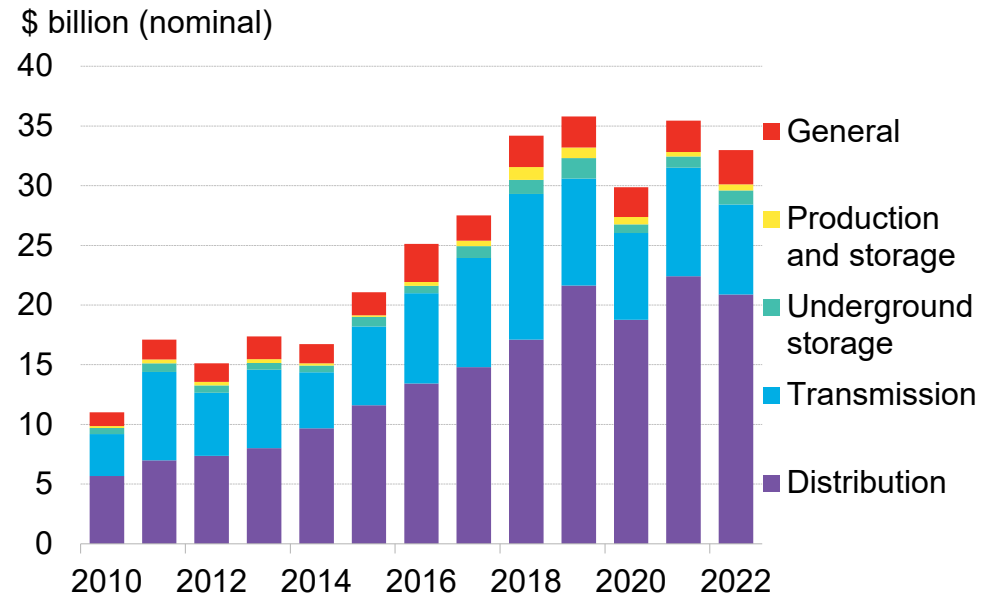
Source: BloombergNEF, World Bank. Note: Start years differ by sector, but all sectors are present from 2020 onwards. Most notably, nuclear figures start in 2015 and power grids in 2020. CCS refers to carbon capture and storage.

# Finance: US midstream infrastructure investment

## US electric transmission investment by investor-owned utilities and independent developers



## US natural gas utility construction expenditures



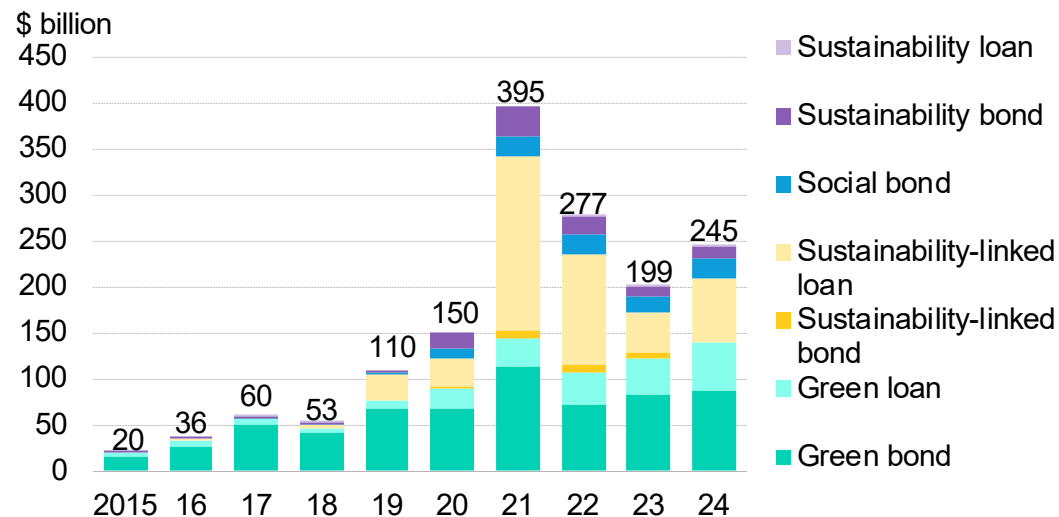
- Investor-owned utilities (IOUs) and independent transmission developers spent \$30 billion on electric transmission in 2023, according to the Edison Electric Institute (EEI). This was up 12% from the year before and far exceeded previous forecasts. The estimate of future investment over 2024-27 was also revised upwards, reaching \$34 billion in 2027. This was driven by new expectations of load growth to support new data centers.
- Midstream gas utility construction expenditures decreased by \$2.5 billion in 2022 from the year prior, to \$33 billion, according to the last year of complete data collected by the American Gas Association. A 17% decrease in transmission investment and 7.7% decrease in distribution investment led to the overall decline in natural gas utility expenditures.

Source: Edison Electric Institute, American Gas Association (AGA), BloombergNEF. Note: Gas expenditure values reflect figures reported to the AGA by companies across the supply chain, including transmission companies, investor-owned local distribution companies and municipal gas utilities. "General" includes miscellaneous expenditures such as the construction of administrative buildings.

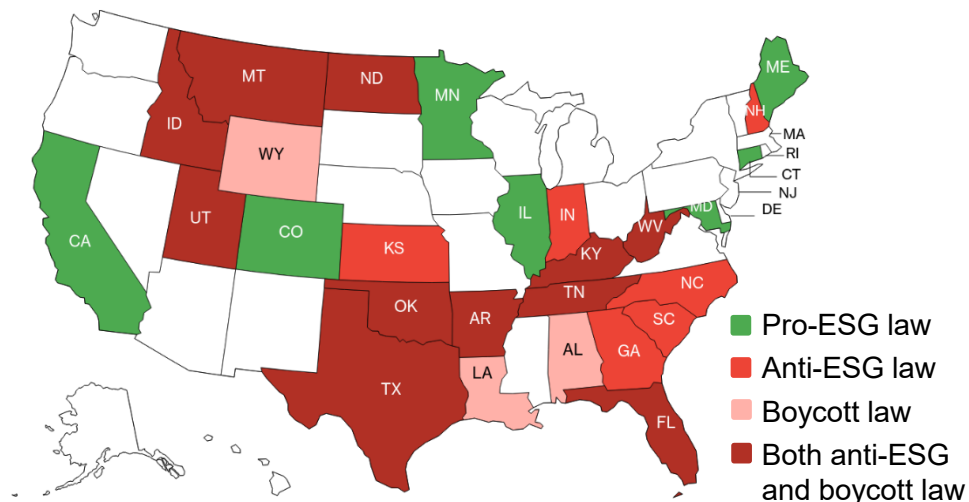


# Finance: US sustainable debt and sustainable finance policy

## Annual US sustainable debt issuance



## ESG laws by US state

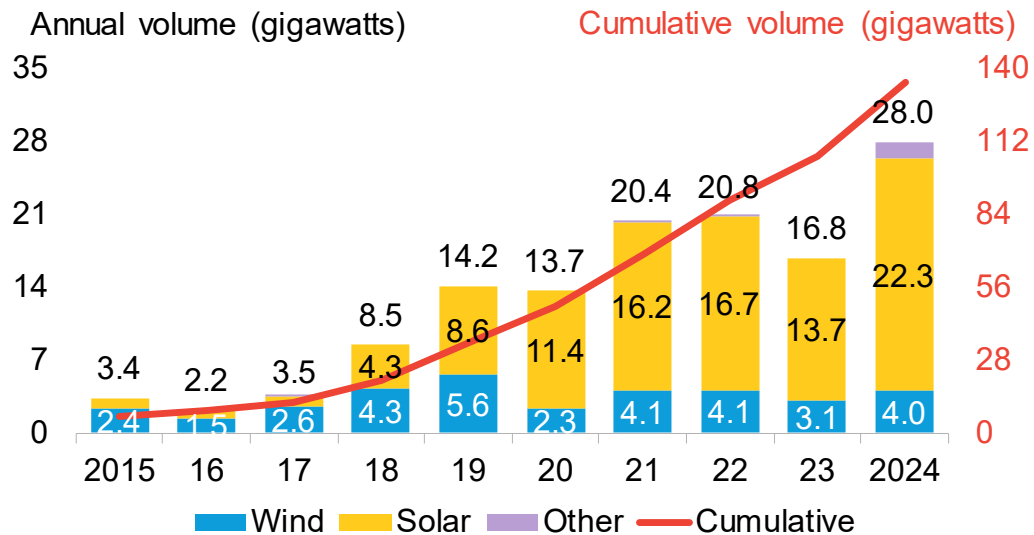


- US sustainable debt issuance rebounded in 2024 to \$245 billion, after two consecutive years of decline. Steady growth in green bond and loan volumes were the main drivers of this growth. As the most established sustainable debt label, these instruments were best positioned to weather the anti-ESG (environmental, social and governance) and greenwashing concerns that have swept the market in recent years. In addition, stabilization of the sustainability-linked debt market, which saw a two-year contraction after its 2021 peak, helped to bolster issuance in 2024. Falling interest rates have likely also contributed to the rebound as debt becomes cheaper to issue.
- Rising anti-ESG sentiment in the US has led 20 states to enact anti-ESG laws in the past four years, most recently Georgia and Oklahoma. The laws typically restrict the consideration of ESG factors when making investment decisions or prohibit states from working with groups that boycott fossil fuels, punishing financial institutions for policies such as divestment goals.
- The Securities and Exchange Commission (SEC) finalized its climate-related financial disclosure rules for listed companies in 2024. However, these have been suspended in the face of legal challenges, and implementation will be driven by the priorities set by a new SEC chair to be appointed by President Trump. California's climate and greenhouse gas emissions disclosure regulations are also facing legal challenges but are still in place. In their current form, these regulations require large companies operating in the state to begin disclosure in 2026.

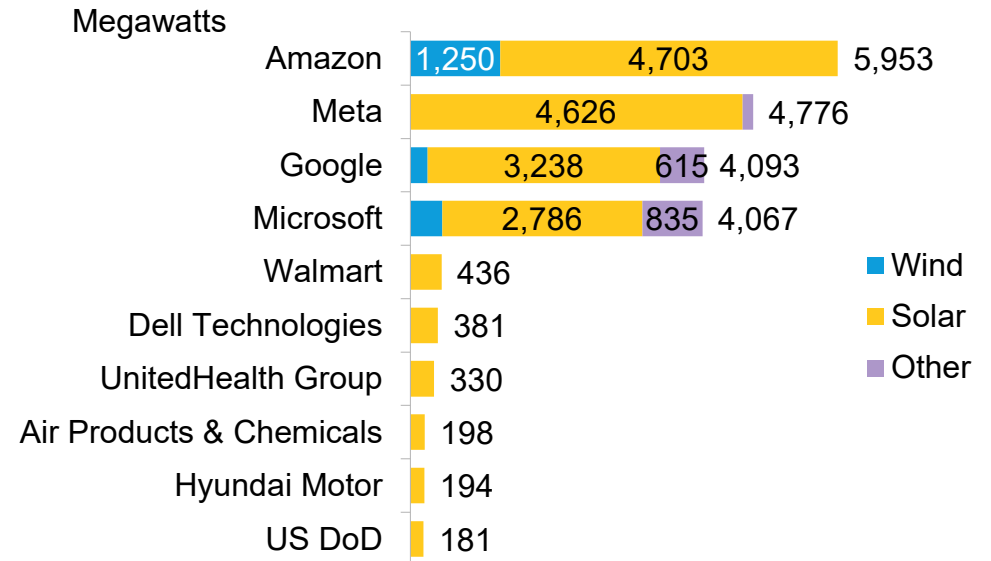
Source: BloombergNEF, US state legislatures, Bloomberg Terminal. Note: Updated as of January 9, 2024. Excludes bills or resolutions. Pro-ESG laws include fossil-fuel divestment laws. Issuance based on market of risk.

# Finance: Corporate procurement of clean power sets new record

## Renewable capacity contracted by corporations in the US, by sector



## Largest corporate offtakers in the US, 2024

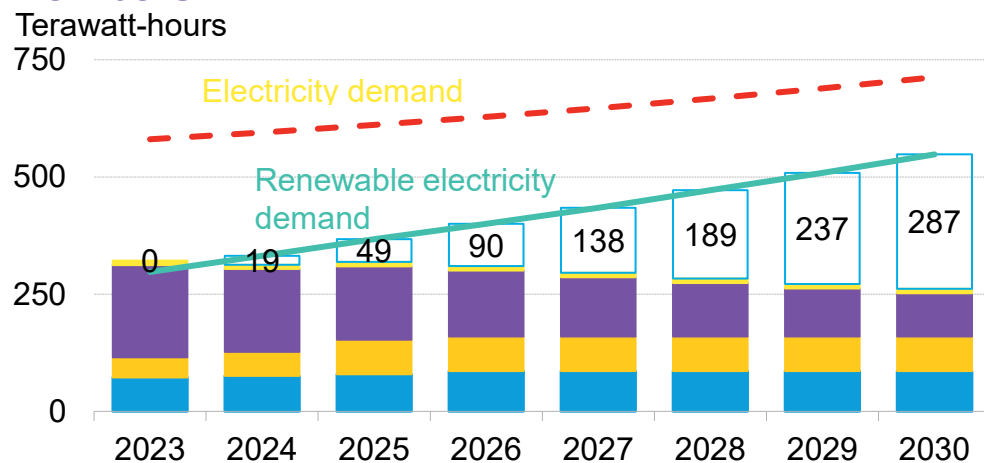


- Corporate power purchase agreement (PPA) volumes announced in the US set a new record – 28GW – in 2024, up 34% from the 20.9GW in 2022. A record 183 deals were signed in 2024, close to double the number of PPAs in the prior year. Solar continued to dominate, making up 80%, or 22.3GW, of all transactions in 2024. Notably, nuclear (1.3GW) and geothermal (0.3GW) PPAs held 5.7% of all deal volumes.
- Tech companies spearheaded this growth, as they were responsible for 84% of overall deal activity, amounting to 22.1GW. Amazon, Google, Meta and Microsoft alone were jointly responsible for 19GW, or 68% of total corporate PPA activity. Amid growing expectations of AI data center demand, and consequent electricity demand, these companies have been purchasing clean energy at record rates to both meet future demand and stay on top of their sustainability targets. The search for clean firm capacity saw a surge of interest in new nuclear projects, with large tech companies signing agreements to reopen shuttered plants (Microsoft's agreement with Three Mile Island) or support next-generation nuclear (Google's agreement with Kairos Power, and Amazon's partnership with X-energy).
- Amazon remained the largest US corporate PPA offtaker in 2024, for the fifth year in a row, as it announced close to 6GW of deals. Familiar names follow on the leaderboard: the next-largest buyers, Meta, Google and Microsoft announced 4.8GW, 4.09GW and 4.07GW, respectively.

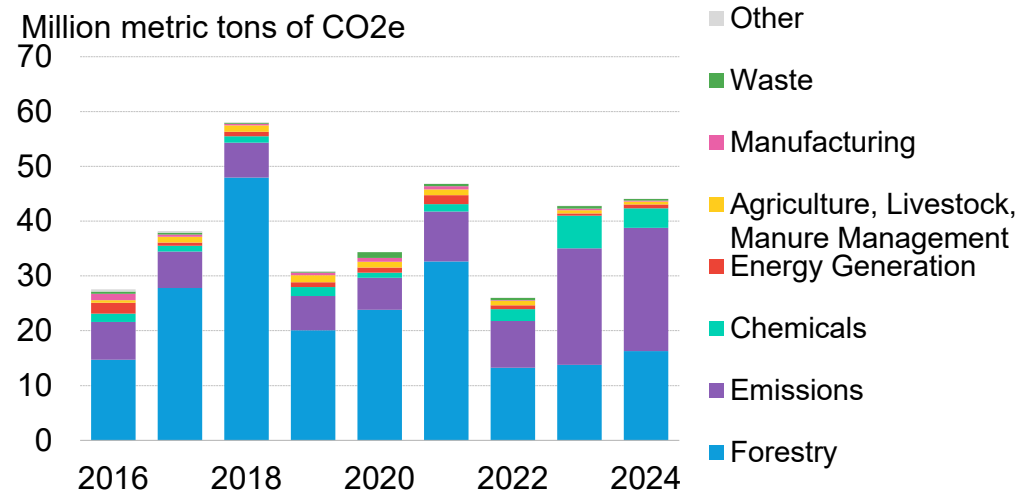
Source: BloombergNEF. Note: Charts show offsite PPAs only. The 'Other' sector includes nuclear and geothermal. US DoD is United States Department of Defense

# Finance: Voluntary markets for decarbonization evolve

## Clean electricity supply and demand for RE100 members



## Annual offset issuance in the US, by sector



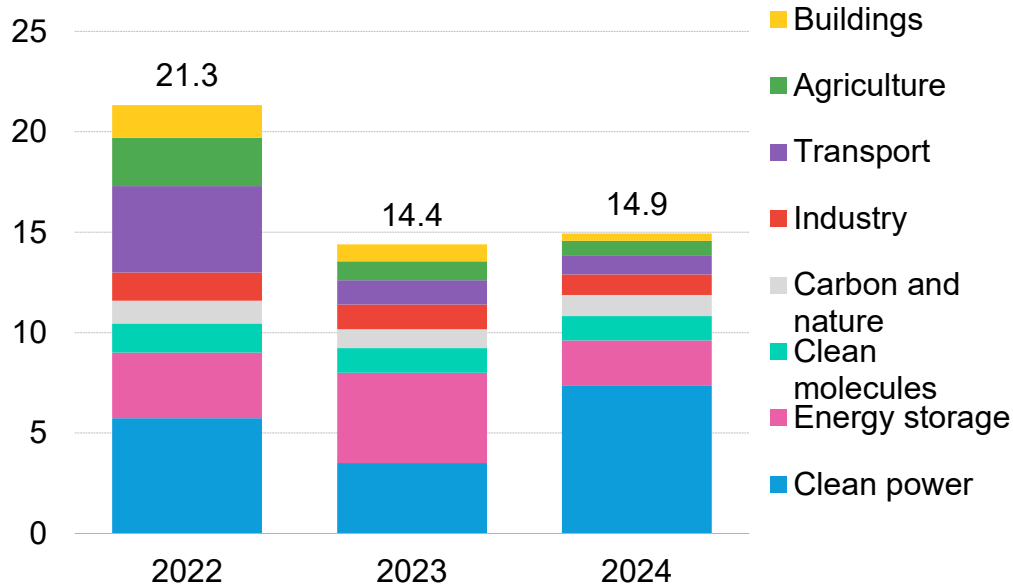
- Some 474 companies have pledged to offset 100% of their electricity consumption with clean energy as part of the RE100, collectively consuming 580TWh of electricity each year based on their latest disclosures. BloombergNEF estimates that the electricity demand from the current group of RE100 members will reach 713TWh in 2030 – roughly equivalent to the annual power consumption of Brazil.
- Just 22 new companies joined the RE100 in 2024; 12 were from the Asia Pacific region. That’s the lowest number of new members since 2014, when 12 companies joined the initiative. With net-zero targets growing in popularity, the initiative has further lost steam as companies consider the benefits and feasibility of 24/7 carbon-free energy.
- In 2024, the voluntary carbon market underwent change and standardization, after facing heavy scrutiny around its environmental integrity in 2023. The US issued 23% of global supply of carbon credits in 2023, more than any other market. Over half of the US carbon credit supply in 2024 was dominated by ‘emissions’ projects that reduce emissions from industrial processes, accounting for 22.5 million credits. High demand and supply for emissions projects was motivated by acquiring high-integrity certifications known as the Core Carbon Principles from the Integrity Council for the Voluntary Carbon Market.

Source: BloombergNEF, Bloomberg Terminal, Carbon Disclosure Project, company filings. Note: In the chart on the left, certificate purchases are assumed to step down 10% each year. Onsite generation and contracted wind and solar purchases remain flat through 2030. Regional breakdown of shortfall is estimated based on each company’s share of revenue by region. Electricity demand and renewable electricity demand do not intersect in 2030, as some companies have targets extending out past 2030. Data as of June 2024. In the chart on the right, ‘Other’ category includes transportation, energy demand, metals. CO2e refers to carbon dioxide equivalent.

# Finance: Venture capital/private equity investment in climate tech

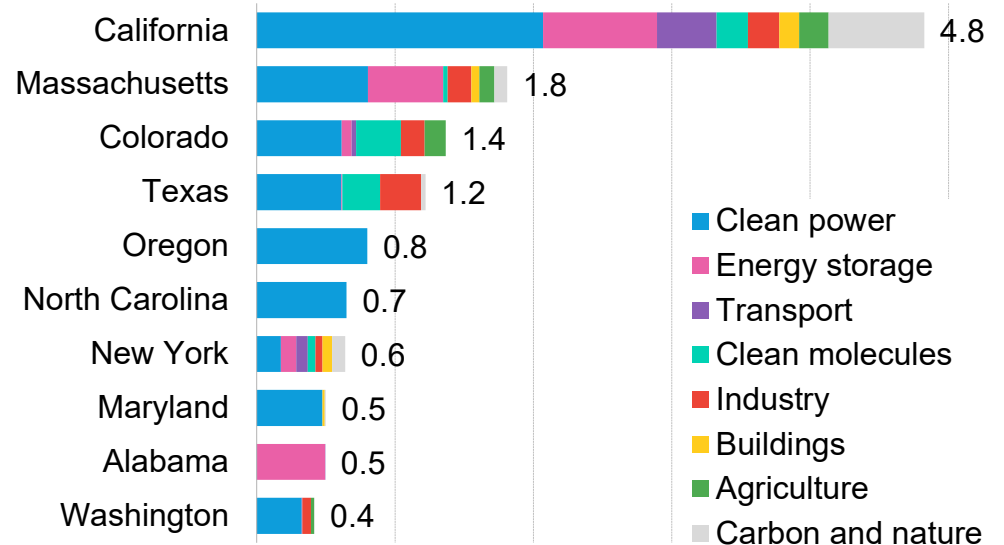
## Climate-tech VC/PE investment, US

Funding (\$ billion)



## Best funded states for climate-tech VC/PE investment, 2024

Funding (\$ billion)



- Venture dollars raised by US-domiciled climate startups totaled \$14.9 billion in 2024 across 272 deals, up a mere 3% from the year prior. This contrasts with the global climate-tech venture market, which saw funds drop 38% year-on-year. However, the growth in the US is consistent with trends recorded for the global venture market across all sectors of the economy, which grew 7% from 2023-24.
- Startups within clean power and energy storage value chains continued to buoy the region's equity raises, bringing in over 60% of the funds. Clean molecules ranked third, driven by e-fuels companies. Low-carbon transport, which ranked third in 2022, fell to sixth place in 2024, due to manufacturing struggles and slowing demand that forced some automakers to scale back production and delay deliveries.
- Firms in California raised the most equity at \$4.8 billion, a third of the country's funds and triple the equity raised in second-place Massachusetts.
- The US continued to be the best-funded market for climate tech, despite some investors slowing capital deployment due to election uncertainty and pending trade disputes. China and the EU followed in second and third place, raising \$5.3 and \$4.4 billion, respectively.

Source: BloombergNEF, Bloomberg Terminal MA< GO>. Note: VC/PE is venture capital and private equity.

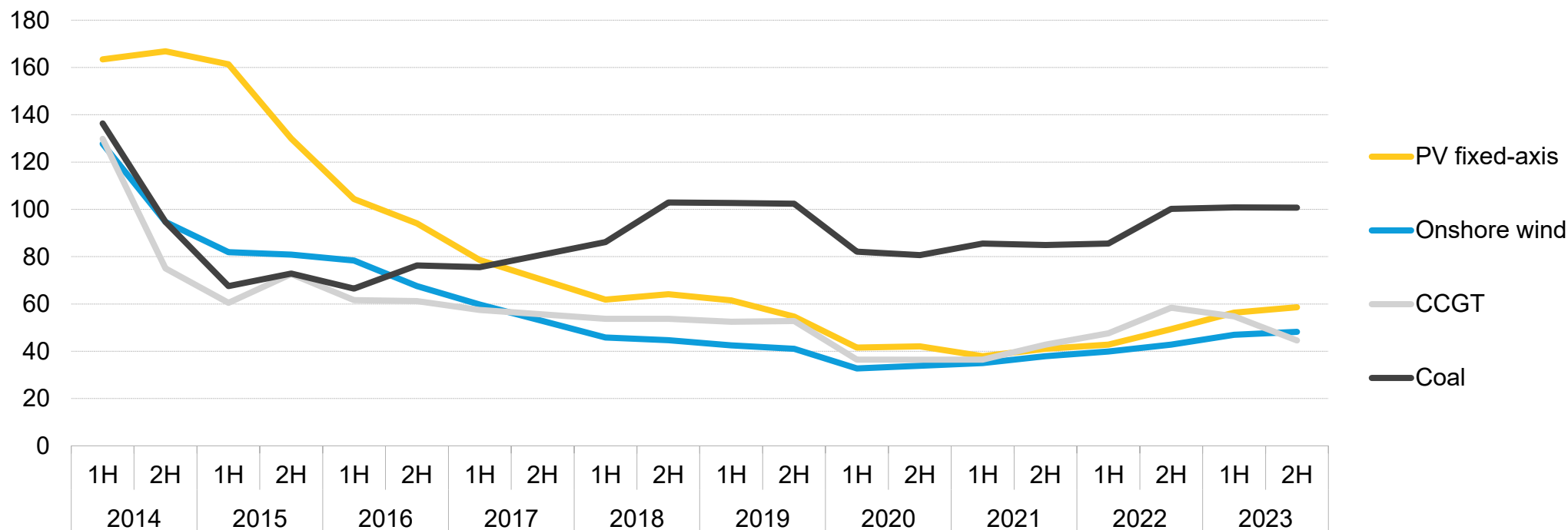
# Table of contents



<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>	<u>6.2 Natural gas</u>	
		<u>6.3 Solar and wind</u>	
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	

# Economics: Benchmark US levelized costs of electricity, 2014-2023

\$ per megawatt-hour (2022 real)

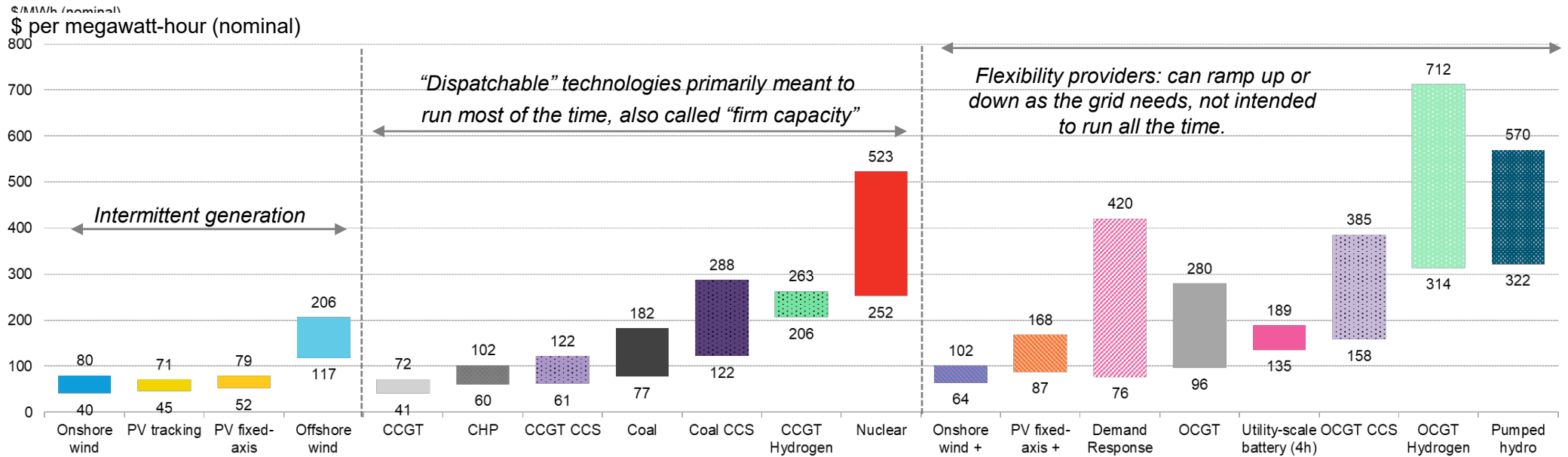


- The levelized cost of electricity (LCOE) for coal remained stable at \$110/MWh over the course of 2023 (reported in nominal terms for 2023 dollars), the last year of complete data published by BNEF. Yet that plateau follows a 10% rise between 2H 2022 and the beginning of 2023, making the fuel less competitive against others as a source of new power generation.
- The LCOE benchmark for combined-cycle gas turbines (CCGT) decreased by 15%, from \$58/MWh in 2H2022 to \$50/MWh in 2H2023, as the price of gas fell from 2022 highs. With 2024 gas prices even lower than 2023 levels, gas-fired electricity was cheaper in 2024.
- Onshore wind's benchmark LCOE increased 20%, from \$43/MWh in 2H 2022 to \$52/MWh in 2H 2023, partly due to volatile steel costs. The LCOE for fixed-axis photovoltaic (PV) solar increased by a benchmark of 27%, to \$63/MWh, during the same time due to higher interest rates and hardware costs. Tax credits for renewable generation (not included here) help offset some of these cost increases.

Source: BloombergNEF. Note: BNEF started collecting country-level LCOE inputs in 2014; prior to 2014, only global LCOE are available. LCOE displayed by financing date. Tax credits are not included. Chart is in real terms, but the numbers in the text are in nominal terms (2023 dollars). CCGT refers to combined-cycle gas turbine.



# Economics: US levelized costs of electricity for unsubsidized new build, 2H 2023

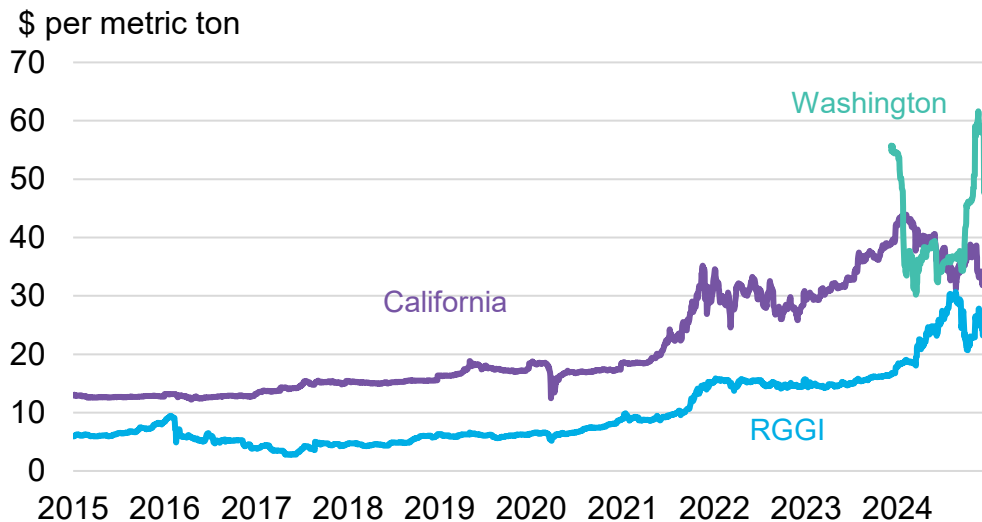


- US LCOEs for most power-generating technologies rose in 2023, with costs associated with PV tracking projects seeing the largest increase (30%) from 2H 2022. This is the last year of complete data tracked by BNEF across all technologies.
- Tax credits help new-build renewables remain cheaper than unsubsidized new gas-fired plants for bulk generation in many areas of the US, except for offshore wind. Onshore wind and tracking PV projects have benchmark LCOEs of \$52/MWh and \$57/MWh, respectively, without subsidies, but with tax credits the respective LCOEs drop to \$37/MWh and \$43/MWh. The LCOE for a new-build gas plant is \$50/MWh.
- The benchmark levelized cost of paired onshore wind-plus-battery (four-hour) systems is \$76/MWh, while solar-plus-battery (four-hour) is \$113/MWh. In comparison, gas peaking plants (open-cycle gas turbines, or OCGTs) have a higher benchmark LCOE of \$137/MWh.
- No new large hydro power plants have been built in the past five years, but the US Energy Information Administration estimates LCOEs in 2028 could range from approximately \$60 to \$90/MWh

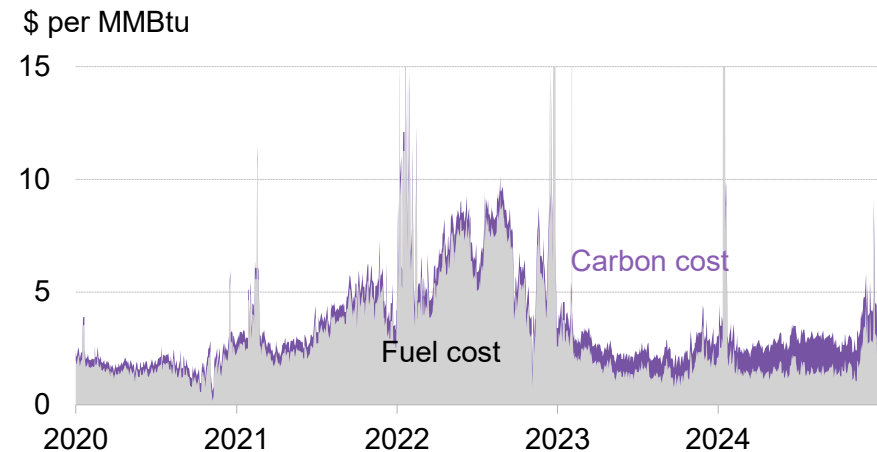
Source: BloombergNEF, US Energy Information Administration. Note: The LCOE range represents a range of costs and capacity factors. Battery storage systems (co-located and standalone) presented here have four-hour storage. In the case of solar- and wind-plus-battery systems, the range is a combination of capacity factors and size of the battery relative to the power generating asset (25-100% of total installed capacity). PV is photovoltaic solar, CCGT is combined-cycle gas turbine, CCS is carbon capture and storage, OCGT is open-cycle gas turbine. All LCOE calculations are unsubsidized. Categorization of technologies is based on their primary use case.

# Economics: Compliance carbon markets' influence over power markets increases

## US compliance carbon prices



## New York's fuel and carbon costs for gas-fired generation



- US carbon prices have been on the ascent in the last five years, encouraging the uptake of low-carbon technologies. Together with other state and federal policies, compliance carbon markets have helped to spur investment in clean technologies while raising revenues for regulators, which can be further reinvested.
- During 2024, the price of both California Carbon Allowances (CCAs) and Regional Greenhouse Gas Initiative (RGGI) shattered records. California reached \$41.76 per metric ton in a February auction while RGGI reached \$25.75 per short ton (\$28.4 per metric ton) in September upon promise of higher climate ambition and resilient emissions. However, towards the end of the year, the momentum for both markets stalled as policy uncertainties came into play. Meanwhile, the carbon price in Washington state, the newest economy-wide carbon market, plunged 59% to \$25.75 in March 2024 from August 2023 highs as the repeal ballot was introduced. The price has since recovered, after the market survived the repeal vote in the November election.
- Carbon prices are playing a bigger role than ever in the US power sector, due to their impact on the cost of natural gas, which is the key fuel for generating electricity. New York, for example, is part of RGGI, a carbon market covering power emissions across 10 states in the northeast of the country. The state saw its carbon costs rising to the equivalent of 75% of fuel costs in 2024, up from 26% in 2020, as the average price of RGGI emission allowances has more than tripled since 2020.

Source: ICE, BloombergNEF. Note: BNEF uses 0.053075 as the gas fuel intensity (metric tons of CO2 equivalent per million British thermal units (MMBtu)). RGGI refers to the US Regional Greenhouse Gas Initiative. MMBtu refers to million British thermal units.

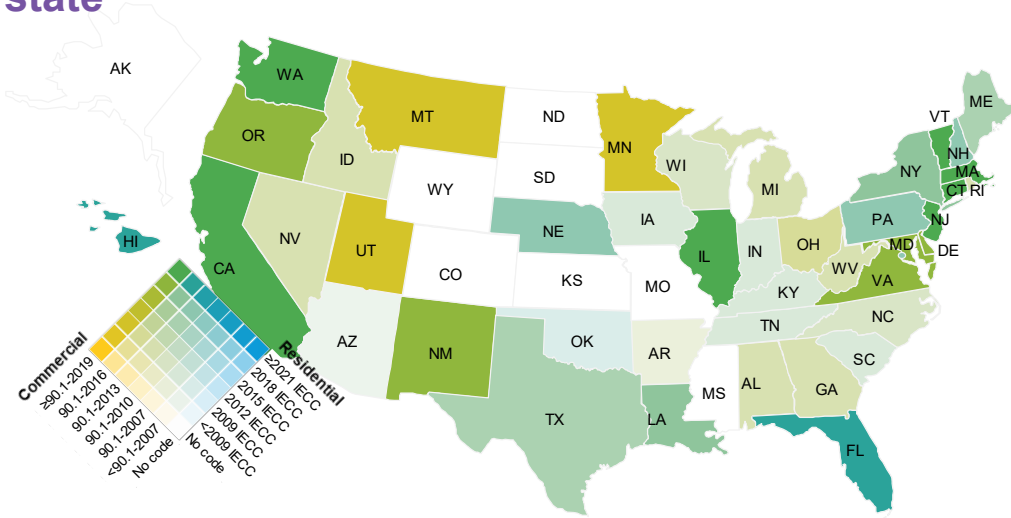
# Table of contents



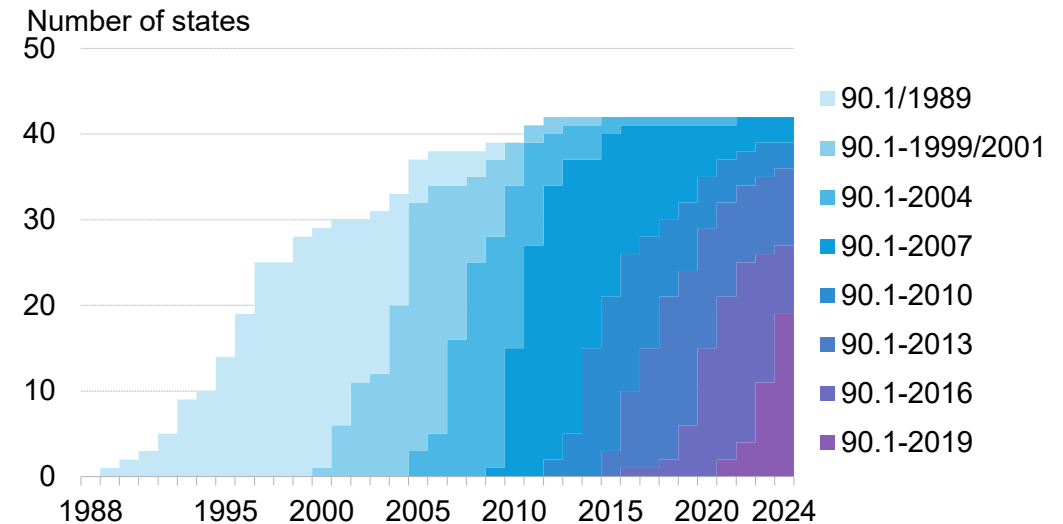
<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>	<u>6.2 Natural gas</u>	
		<u>6.3 Solar and wind</u>	
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	

# Deployment: Statewide energy code adoption

## Residential and commercial building codes, by state



## Commercial building code adoption among states, over time

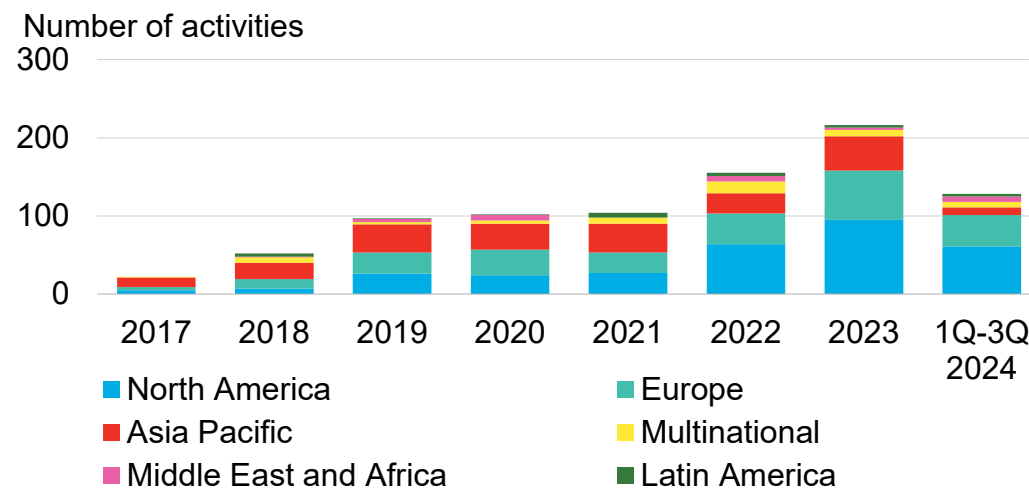


- Building energy codes set minimum standards for both new buildings and renovations. The International Energy Conservation Code (IECC) sets standards for both residential and commercial buildings, while the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90.1 is an alternative standard to IECC provisions for commercial buildings (and is an alternative pathway to meet IECC). The most recent editions of IECC and Standard 90.1 are considerably more ambitious than their predecessors. Analysis by the US Department of Energy estimates that the 2024 IECC leads to average on-site efficiency gains of 7.8% over the 2021 edition. Similarly, the most recent Standard 90.1 edition, released in 2022, is estimated to average on-site efficiency gains of 9.8% relative to the 2019 version.
- Building energy codes can be adopted at a state level, but some local governments set more stringent requirements. For example, Texas requires a minimum performance 90.1-2013 in commercial buildings, but cities like Houston, Austin, Dallas and San Antonio require new construction to meet 90.1-2019.
- Building Performance Standards (BPS) are laws that improve the performance of large existing buildings by setting minimum performance requirements and deadlines. By January 2025, the National BPS Coalition had grown to six states and 42 localities, of which four states (Washington, Colorado, Maryland, and Oregon) and ten localities have already adopted BPS.

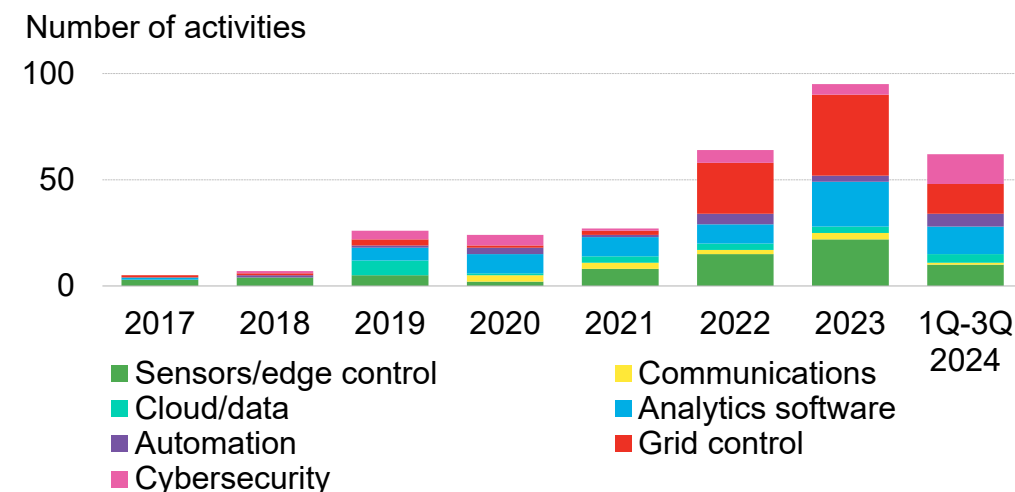
Source: EERE, BloombergNEF. Note: The maps represent EERE analysis of energy savings impacts from state code adoptions. Any code for which the Energy Index is not more than 1% higher than that of an IECC or Standard 90.1 edition is considered equivalent to that code edition.

# Deployment: The US is maintaining its lead in power digitalization

## Power sector digitalization, by region



## North America power sector digitalization, by technology area

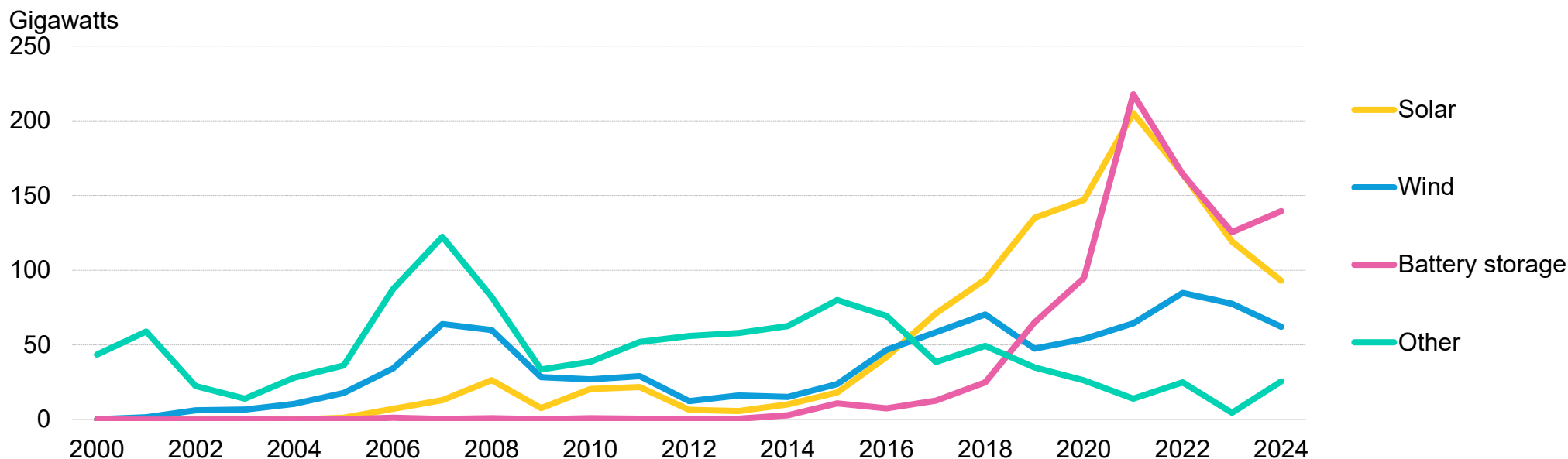


- BNEF tracked 128 public announcements of digitalization projects and partnerships in the power sector globally in the first three quarters of 2024, suggesting that the sector will likely maintain the level of digitalization seen in the past two years. The US accounted for the largest share (43%) of global digitalization activities in 2023 and 2024, in part driven by US Department of Energy (DOE) funding.
- Some 30% of US digitalization activities in 2023 got funding from the US DOE's Grid Resilience and Innovation Partnerships (GRIP) program. For instance, American Electric Power received a \$27.8 million GRIP grant to support its advanced distribution management system (ADMS) and distributed energy resource management system (Derms) program. These are examples of grid control software, which drove power digitalization in North America in 2023 with a 40% share of all activities in the region that year.
- The US is continuing to ramp up its cyber resilience efforts, with about a quarter of activities in the first three quarters of 2024 in cybersecurity. The DOE announced \$45 million in funding in February 2024 for cybersecurity projects that support grids, distributed energy and renewables. The funds went to projects such as encryption-based communication mechanisms and artificial intelligence (AI) for threat detection. For instance, the Electric Power Research Institute got funding to make AI models to help detect and respond to cyber incidents at the grid edge.

Source: BloombergNEF. Note: For more on this topic, see BNEF's Digital Trends in Power series.

# Deployment: Renewables fill interconnection queues

## Total yearly generation capacity that applied for interconnection to US ISO power grids

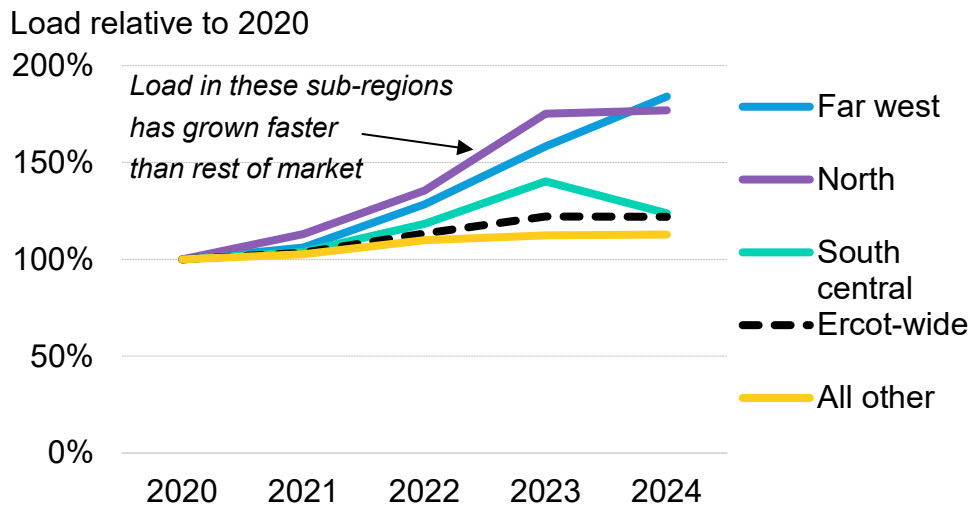


- Some 317GW of projects have applied to connect into the grids operated by the seven US independent system operators (ISOs) in 2024, with solar and storage projects leading the way. The majority of new projects are in Texas, followed by PJM Interconnection.
- Following a rush to enter projects into the queue over 2021-22, new applications have seen a relative decline. However, with an estimated 93GW of solar and 139GW of storage capacity seeking connection to the grid in 2024, system operators still have their hands full processing the backlog of applications.
- New wind projects seeking to come online have also dipped, with only 60GW applying in 2024. New wind build has lagged the pace of solar and storage, as wind generation saturates its traditional markets in the wind belt, and pipelines are slow to build up in other regions.
- In 2024, non-renewable capacity trying to come online in US power markets ticked up from record lows, as hopes of load growth across the country revived interest in baseload power generation.

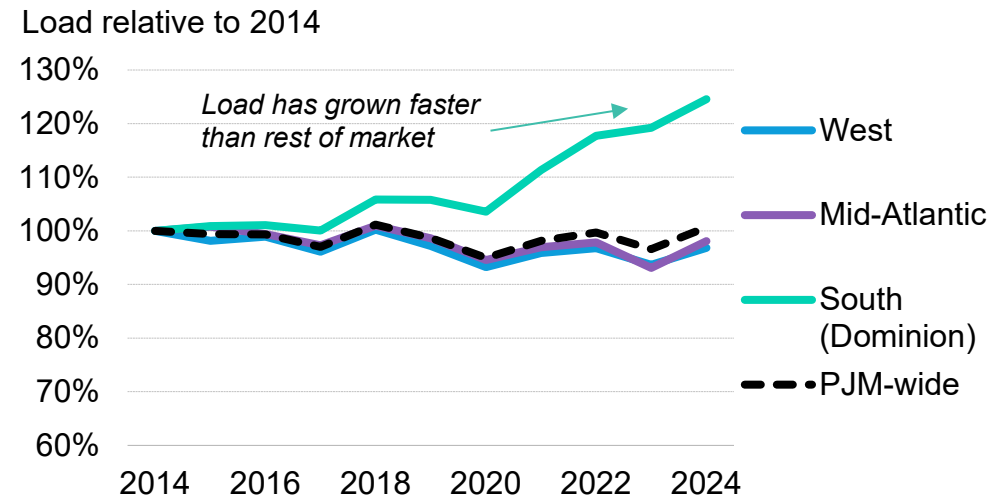
Source: *California Independent System Operator (Caiso), ISO-New England, Midcontinent Independent System Operator (MISO), New York Independent System Operator (NYISO), PJM Interconnection, Southwest Power Pool (SPP), Electric Reliability Council of Texas (Ercot), Berkeley Lab, BloombergNEF.* Note: Caiso covers California, ISO-NE covers New England, MISO covers the Midwest ; NYISO covers New York, PJM covers the Mid-Atlantic ; SPP covers the central southern US; Ercot covers most of Texas.

# Deployment: Impact of growing load due to industrial activity

## Load by sub-region, Ercot (rebased to 2020)



## Load by region, PJM (rebased to 2014)

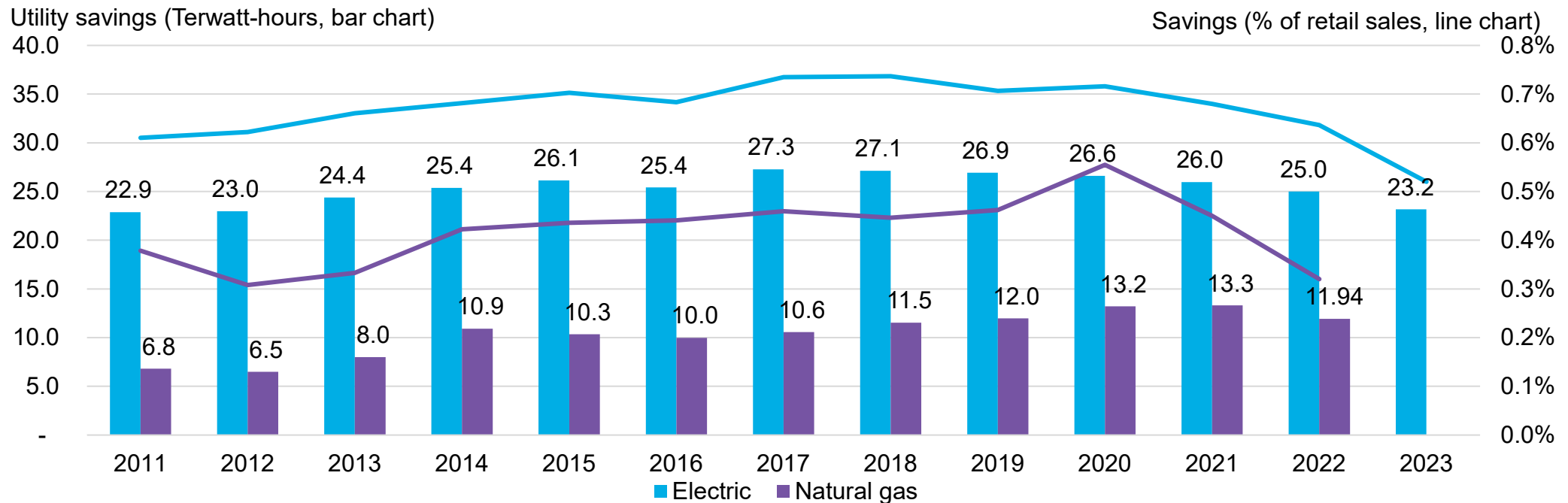


- Over the past year, load growth has dominated the conversation around power demand, as development in power-intensive AI applications and the need to build more data centers to support them gripped the national imagination. This builds upon the growth in power demand in some parts of the country due to increased domestic manufacturing, and electrification of end-use applications.
- Two markets where power demand growth has been apparent over the past few years are Texas and the PJM sub-region in northern Virginia. In Texas, industrial activity – particularly the steady electrification of oil and gas extraction in the Permian basin (in the far west of Texas) – has already driven up power demand in Ercot. Data centers have also been a driver; as of September 2024, 5.5GW of data centers were approved to energize, or connect onto the grid. Of this, 3.3GW was crypto mines that were already operating. Combined with weather factors, Ercot's power demand has risen 17% compared to 2021, with the summer peak going from 73GW in 2021 to 86GW in 2024.
- Northern Virginia, the largest data center hub in the world, has seen power demand growth steadily rise and dominate the topline power consumption estimates for the local utility, Dominion Energy. The effect of sustained data center buildout in this region has pushed Dominion's power consumption up by 25% since 2014, to a total of 115TWh in 2024. Other regions in PJM, by contrast, saw power demand remain flat or slightly decline over the same time period. More utilities have reported interest from developers of data centers, as well as direct interest from large tech companies, such that by late 2024, PJM was expecting the summer peak to rise by 25% in 2030, compared to 2024 levels.

Source: Electricity Reliability Council of Texas (Ercot), PJM Interconnection (PJM), BloombergNEF



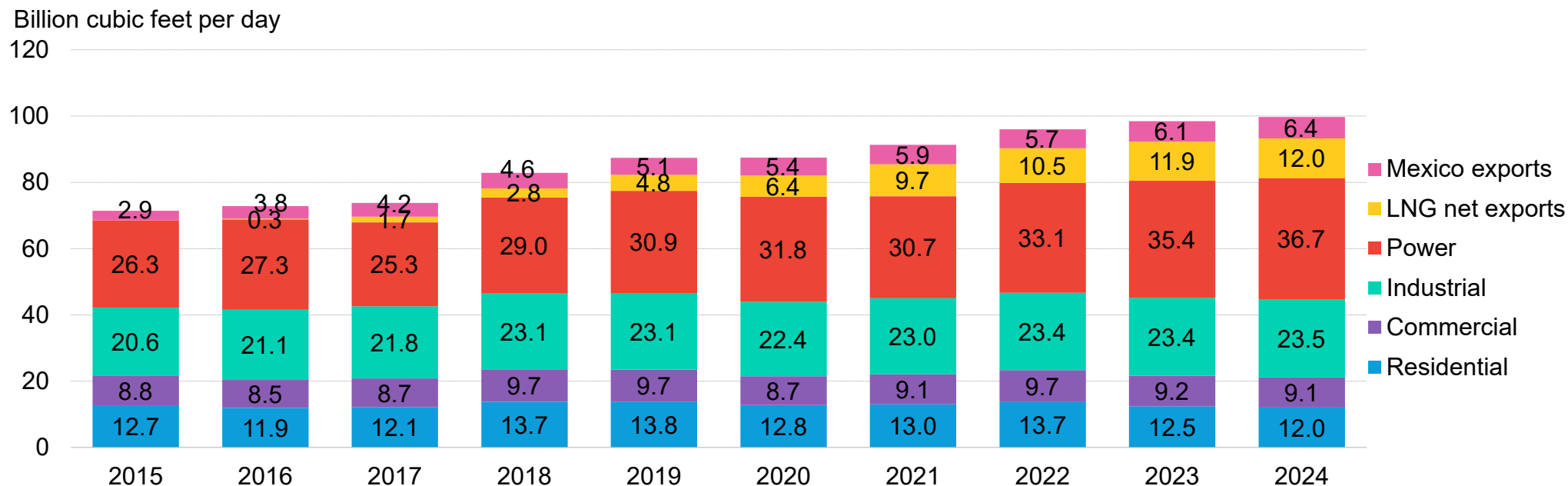
# Deployment: Incremental annual energy efficiency achievements by utilities



- Since 2011, the number of states with energy efficiency resource standard (EERs) policies has stagnated, with one state either adding to the list or leaving it each year. As utility investments in energy efficiency declined during the pandemic, the amount of energy saved from efficiency measures also slipped – both in absolute terms and as a share of retail sales.
- Electric utilities in 2023 saved 23.2TWh of energy, equivalent to 0.52% of retail sales. As savings fell year-on-year even as retail electricity sales across the country rose, the fraction of retail sales “saved” shrank. In 2022, the last year for which there is complete data on gas utility efficiency, savings dropped to 11.9TWh compared with the year prior. This represents 0.32% of retail sales in that year. Preliminary data for 2023 from the ACEEE indicates a 16% increase in savings on the natural gas side, consistent with an increase in spending.

Source: American Council for an Energy-Efficient Economy (ACEEE), American Gas Association (AGA). Note: The ACEEE data points to caveats in the energy efficiency savings data reported by states. ACEEE uses a standard factor of 0.825 to convert gross savings to net savings for those states that report in gross rather than net terms. The ACEEE currently reports electric and natural gas savings separately in their report, but a handful of states have been considering savings on a fuel-neutral basis, which is appropriate when electrification brings a net positive effect on emissions. ACEEE may adjust their methodology if this practice becomes commonplace.

# Deployment: US natural gas demand, by end use

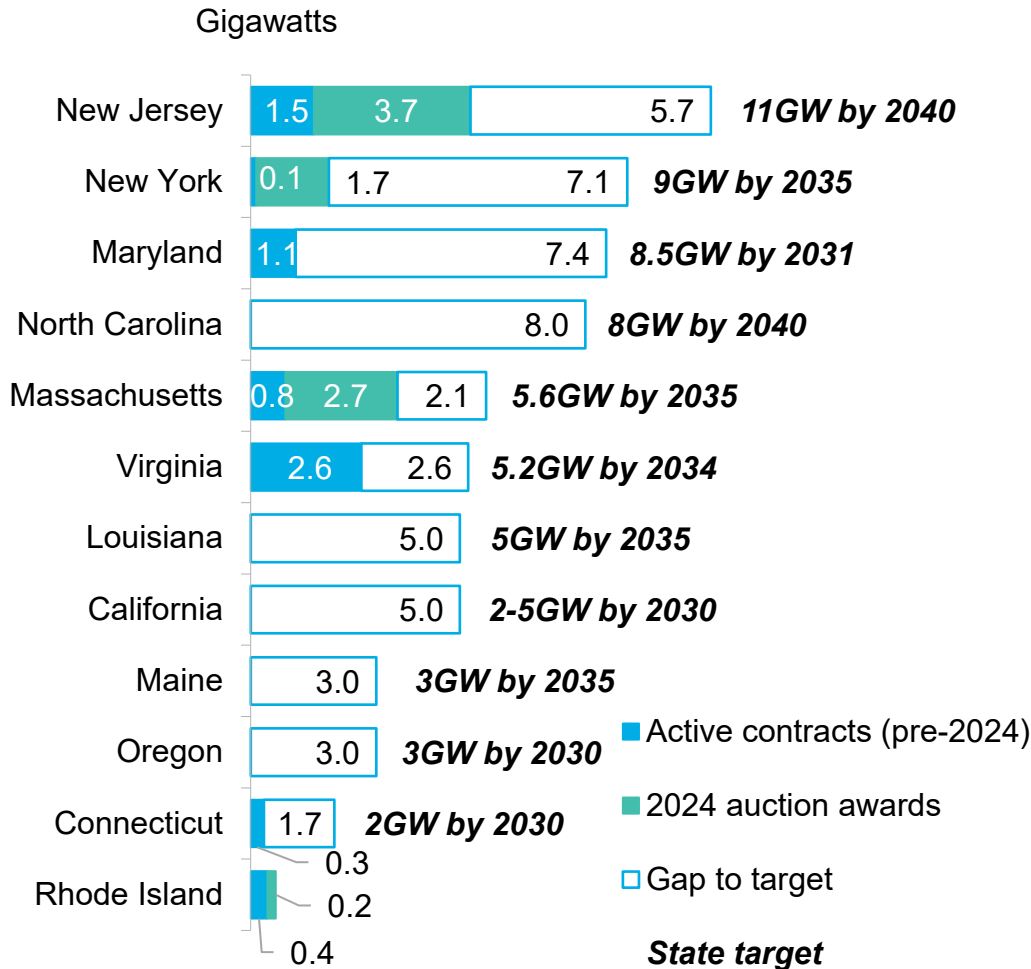


- Demand for US natural gas rose 1.2 billion cubic feet per day (Bcf/d), or 1.3%, in 2024 from the year prior to reach 99.7Bcf/d. The rise was driven by strong power sector consumption, rising liquified natural gas (LNG) exports, and increased exports to Mexico. Conversely, commercial and residential demand fell by 1% and 4%, respectively. Abnormally warm weather in the first quarter of 2024 led to considerable amounts of heating demand destruction.
- Bloated natural gas inventory levels after a mild winter of 2023-24 gave way to suppressed prices throughout most of the year. The Henry Hub front month contract fell as low as \$1.58 per million British thermal units (MMBtu) at the end of the winter season. Improved gas plant economics due to relatively low natural gas prices, along with coal plant retirements, helped set new highs for daily power sector gas consumption, which grew 3.7% year-over-year.
- LNG feedgas consumption growth slowed to 1.23% year-on-year – slower than expectations, and the slowest yearly growth rate since the US became a net exporter – after new export terminals suffered delays throughout the year.

Source: BloombergNEF, US Department of Energy. Note: November and December 2024 values are Bloomberg estimates. LNG refers to liquefied natural gas.

# Deployment: Progress towards state offshore wind targets

## Status of contracted offshore wind capacity and targets across US states

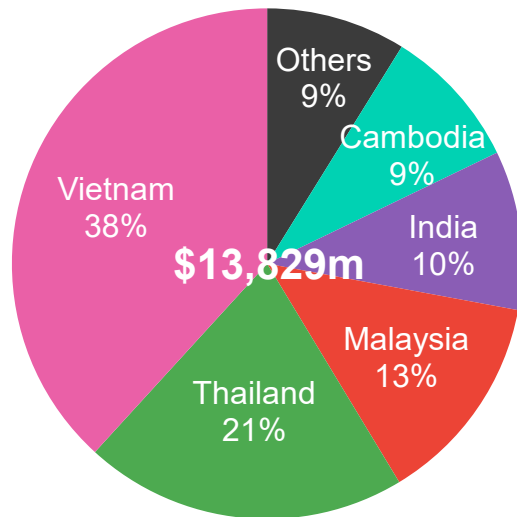


Source: BloombergNEF, news reports, company filings and announcements.  
Note: GW is gigawatts.

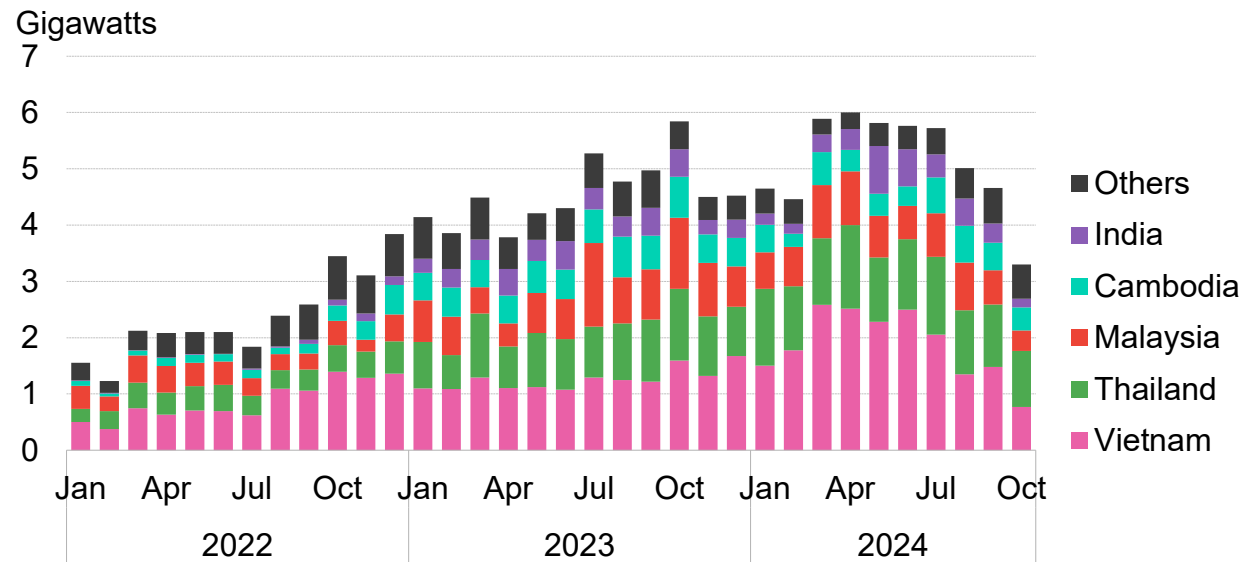
- The offshore wind industry is facing policy headwinds that could last through the entire period of the new administration's term, until January 2029.
- Four states – New Jersey, New York, Rhode Island and Massachusetts – procured a total of 8.3GW of offshore wind power in 2024. In August, Rhode Island and Massachusetts selected 2.9GW of capacity in a tri-state solicitation, first announced in 2023. New York selected 1.7GW of projects in February, while New Jersey awarded 3.7GW of new contracts in January 2024.
- Several project developers that sought contract renegotiations in 2023 secured new offtake deals in 2024 or are on course to getting new contracts in 2025. About 3.8GW of project capacity where developers terminated past offtake deals won new contracts in 2024.
- Interest in securing new seabed leases was low in 2024. The Bureau of Ocean Energy Management (BOEM) canceled a Gulf of Mexico auction and delayed a round in Oregon, while auctions in the Gulf of Maine and Central Atlantic fetched low fees.
- BOEM issued five 'Records of Decision' – a document approving project construction activities – for 10.8GW of offshore wind capacity in 2024. This is the highest number the US has completed in a single year and includes projects from developers like Orsted, Avangrid, Shell-EDF, US Wind and EDP Renewables-Engie.
- Orsted reached a final investment decision on its 924MW Sunrise Wind project in 1Q, while Equinor closed financing for the 810MW Empire Wind 1 toward the end of 2024. The two projects that first secured offtake contracts in 2019 got new procurement deals in New York's fourth offshore wind solicitation in February 2024.

# Deployment: US imports of PV modules

US imports of PV modules, by origin, January to October 2024



US imports of PV modules, by month and origin

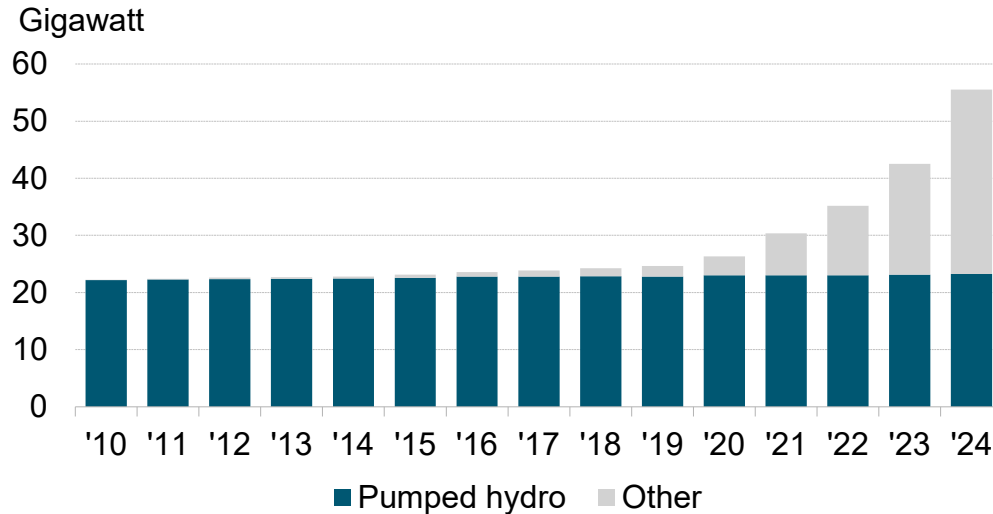


- The US imported over 51GW of PV modules in the first 10 months of 2024, 12.3% more than during the same period in 2023. In April 2024, the country recorded a monthly module import record of 6GW that dropped to 3.3GW in October of the same year. There was a moratorium on anticircumvention tariffs for subject cell and module imports from Cambodia, Malaysia, Thailand and Vietnam (CMTV). The moratorium ended June 6, 2024, and subject products had until December 3, 2024, to install product, or else be exposed to cash deposits.. BNEF estimates over 30GW of module inventory could not be installed before the December 2024 deadline and may have to pay tariffs to be used later.
- As new domestic silicon module assembly factories ramp up, US cell imports have grown to \$1.5 billion last year as of October, a 154% increase compared to the same period in 2023. Cell imports peaked in September 2024, when the country received 1.7GW of cells.
- The US announced preliminary countervailing duties on cells and modules from CMTV in October 2024 and antidumping duties in November 2024. Tariff rates vary by company, with combined preliminary rates ranging from 14.72% to 563.89%. Tariff rates are subject to change in the final decision. Some manufacturers are already shifting their supply chain and using cells produced outside of the four Southeast Asia countries. Modules from Laos were imported into the US market on a large scale for the first time in July 2024. In October, modules from Laos and Indonesia reached 0.27GW and 0.26GW, respectively, making them the fifth- and sixth-largest countries of origin for solar modules.

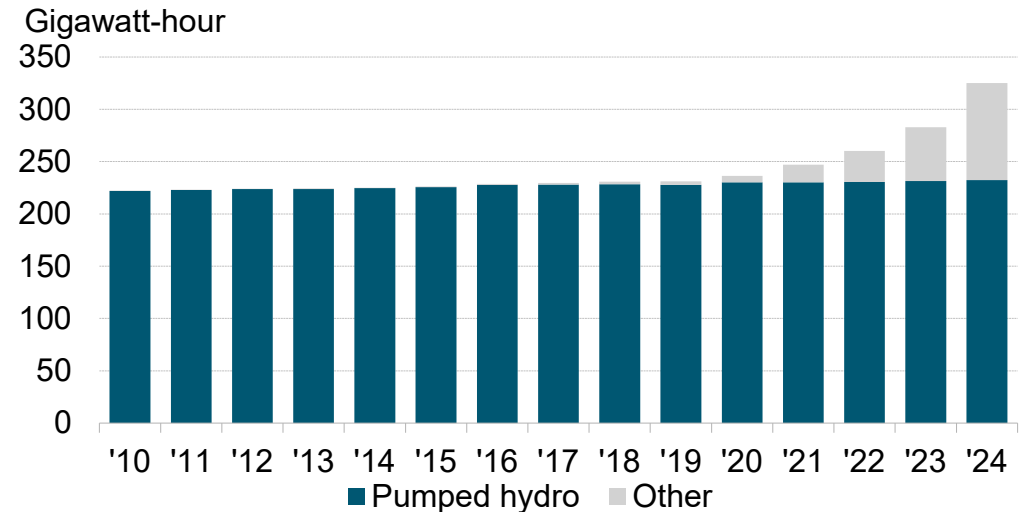
Source: BloombergNEF, [US International Trade Commission Data Web](#). Note: Free-on-board (FOB) value excludes US import duties, freight, insurance and other charges. First Solar's thin-film module is free from Section 201 duty. See monthly average selling price (ASP) derived from US International Trade Commission statistics. PV stands for photovoltaic solar.

# Deployment: US cumulative energy storage

## Commissioned US energy storage capacity



## Commissioned US energy storage capacity

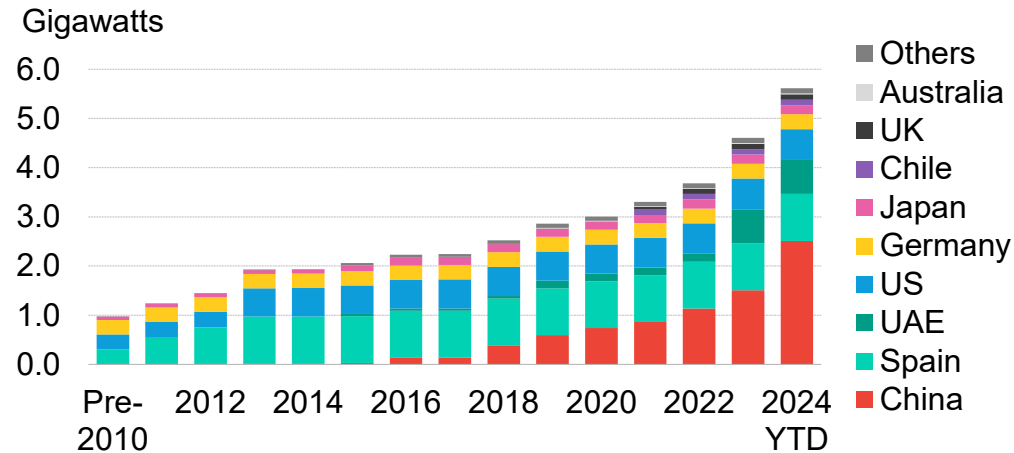


- Cumulative US energy storage capacity exceeded 55GW in 2024 – a 31% increase year-on-year driven by non-hydro energy storage. Total non-hydro energy storage capacity is estimated at 31.5GW at the end of 2024 on a cumulative basis, overtaking pumped hydro capacity (23.2GW) for the first time in history. There was one pumped hydro capacity addition in 2024 – an 80MW net capacity addition related to an upgrade of Duke Energy’s Bad Creek plant to 1,680MW.
- Non-hydro energy storage additions, including batteries distributed across homes and businesses, exceeded 10GW for the first time, jumping 55% to reach 11.9GW in 2024. Development incentives through the Inflation Reduction Act helped accelerate this growth, as did falling costs of energy storage systems, which are strongly tied to lower battery prices due to overcapacity and fierce competition among battery manufacturers. The US remains second to China based on annual non-hydro energy storage installations since 2023.
- California, Texas and various states in the Southwest continue to lead the deployment of battery energy storage systems, representing 84% of annual build in 2024. In California, high solar penetration and long-term contracts continue to encourage additions of non-hydro energy storage. Projects in Texas eye opportunities in Ercot’s huge energy price volatility and ancillary services. In the Southwest, vertically integrated utilities procure energy storage capacity based on their integrated resource plans (IRPs). The largest project was Gemini Solar (380MW) in Nevada.

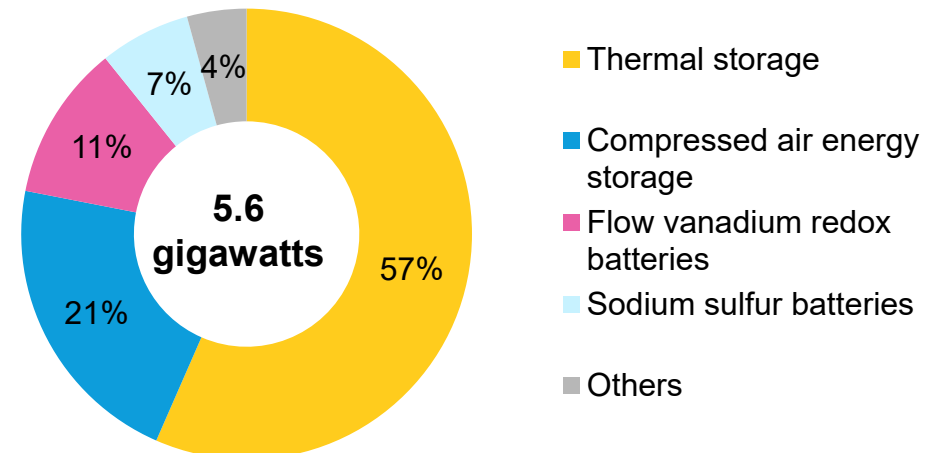
Source: US Energy Information Administration, Federal Energy Regulatory Commission (FERC), BloombergNEF. Note: “Other” includes projects where the technology is unknown, which is frequently lithium-ion batteries. Assumes ten hour discharge duration for pumped hydro facilities.

# Deployment: Long duration energy storage

## Cumulative long-duration energy storage installations, by market



## Installed long-duration energy storage power capacity, by technology

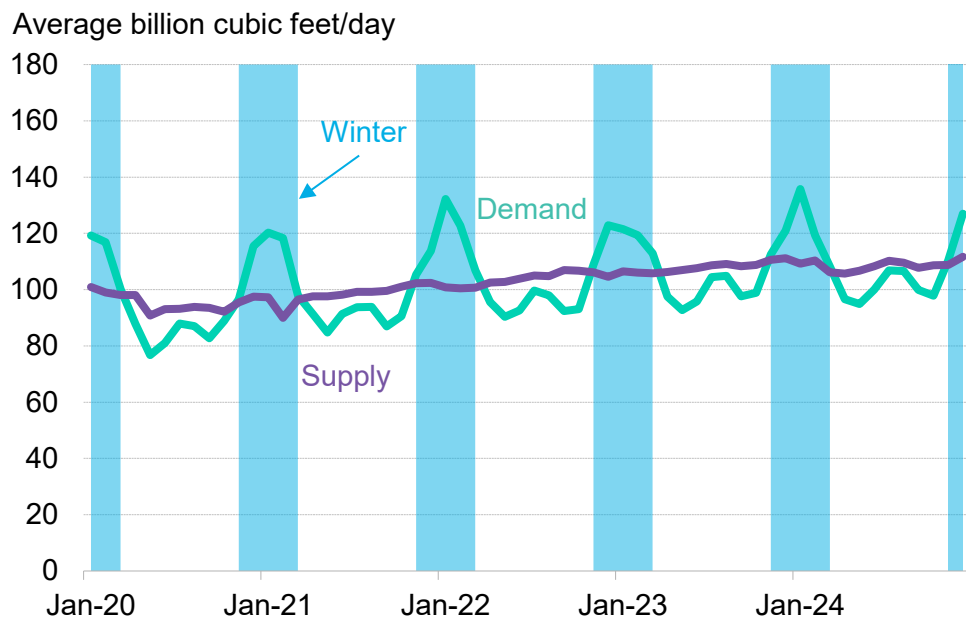


- Long duration energy storage (LDES), which enables the discharge of power over extended periods of time, has seen steadily growing interest globally. While there is no widespread consensus on the definition of LDES, BNEF includes in this category technologies that can offer continuous discharge at their maximum power capacity for at least six hours.
- Global long-duration energy storage deployment reached a record high in the first nine months of 2024 alone, surpassing 1GW/4.6GWh of new annual capacity for the first time. China dominates the market, accounting for 99% of installations over this period, and also has the largest installed base, with the US in fourth place. The top five markets – China, Spain, the UAE, the US and Germany – account for around 90% of total installations.
- In the US, California regulators have approved the procurement of up to 2GW of LDES as part of the state's procurement of 10.6GW of clean energy to meet resource adequacy needs. These tenders are currently scheduled to happen in 2026. Other utilities, including Arizona-based [Salt River Agricultural Improvement and Power District](#), are starting to model and procure long duration storage as well.
- The leading technology within LDES remains uncertain. The current global installed base is dominated by thermal storage, but the 76GW of announced pipeline suggests a diverse range of technologies is being explored. Compressed air storage is the most popular technology in the pipeline, followed by vanadium redox flow batteries, thermal storage and gravity storage.

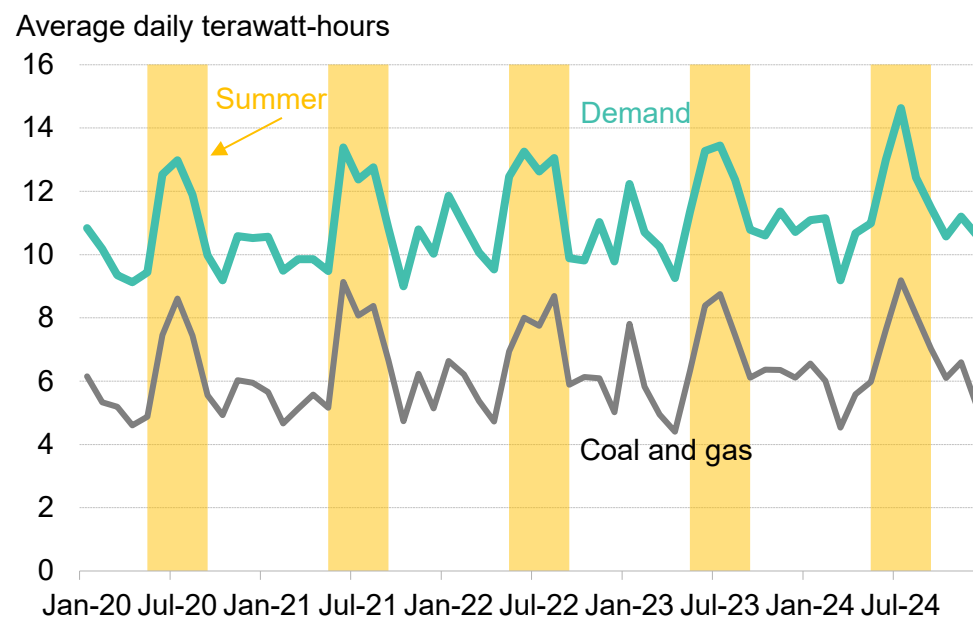
Source: BloombergNEF. Note: For projects without disclosed duration information, we assume the minimum duration requirement for long-duration energy storage based on the standards in different markets

# Deployment: Seasonal storage needs

## Average gas production and demand



## Average electricity demand and thermal generation



- Seasonality in energy demand has typically been met by some form of storage. Thermal fuels, like coal or gas, can be stored either on-site or in specialized underground reservoirs, and are thus arguably as much a form of energy storage as batteries and pumped hydro.
- The gas market typically sees demand surge in winter, as the fuel is used to heat homes, businesses and industry. Contribution from underground storage helps meet the higher heating needs. During times of high demand, storage can meet up to 50% of daily natural gas demand. An average of 9.8 billion cubic feet per day was consumed from storage over winter 2023-24 (November through March).
- The power market tends to see demand surge in the summer, and it meets this demand by generating more electricity. The two major sources of electrical energy storage are pumped hydropower reservoirs and lithium-ion batteries. However, both these means of storage are focused on hourly shifting, such as up to 20 hours at a time (hydro), or four to six hours (batteries). The power market currently relies on being able to generate more electricity by burning fossil fuels to meet seasonal surges in power demand, rather than seasonal electricity storage.

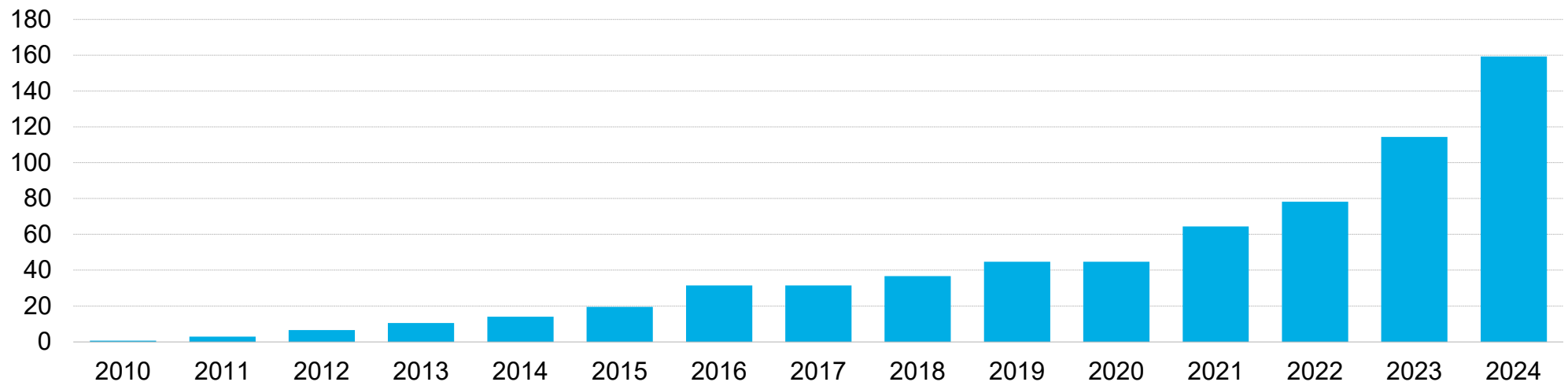
Source: BloombergNEF. Note: Gas supply includes imports from Canada. Demand includes exports to Mexico and liquefied natural gas (LNG) feedgas demand.



# Deployment: Current battery manufacturing capacity

## Cumulative US lithium-ion battery cell manufacturing capacity

Cumulative capacity (gigawatt-hours per year)

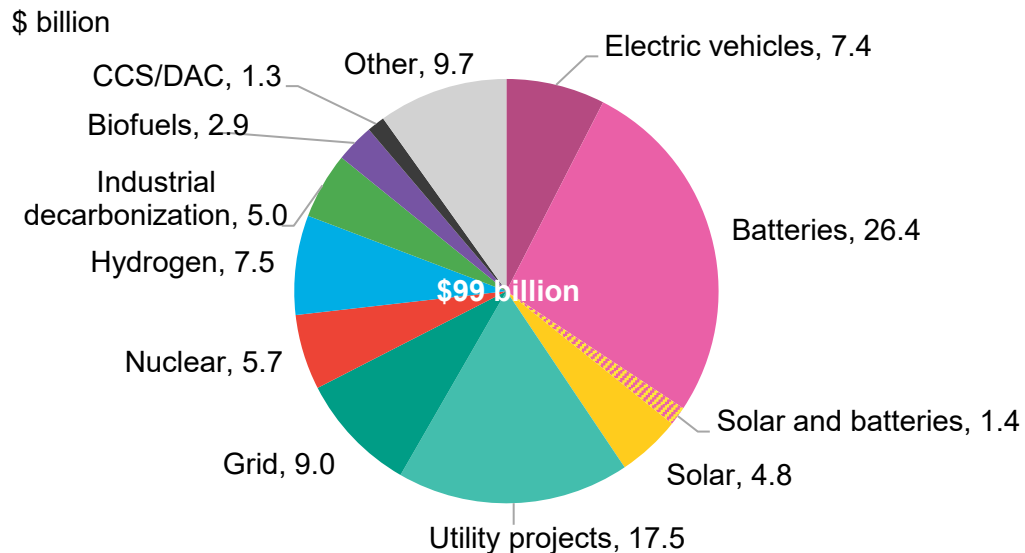


- By the end of 2024, the US had 159 gigawatt-hours (GWh) of annual lithium-ion battery manufacturing capacity, a growth rate of 45GWh from 2023, or 39%. Additions in 2024 included Ultium's 35GWh plant in Tennessee, from the joint venture between GM and LG Energy Solution. Most US battery production capacity is oriented toward cells for electric vehicles rather than stationary storage. In 2024, there were significantly fewer announcements for new capacity than during the previous year, but notable announcements included Lyten's 10GWh plant for lithium metal batteries in Nevada and Enersys' 4GWh plant in North Carolina.
- The rapid growth in battery manufacturing announcements in the US in recent years is now facing challenges. Local manufacturers are dealing with difficult economic conditions, fierce price competition from players in China, and slower-than-expected EV demand growth. The relative immaturity in terms of production expertise and supply development compared with China also adds challenges in scaling production. This combination of factors led companies to take a more reserved approach to expansion in 2024. Recent developments such as Northvolt's [bankruptcy](#) in the US and GM's move to [sell its stake in its Michigan plant](#) to its co-owner, LG Energy Solution, also highlight the industry's challenges.

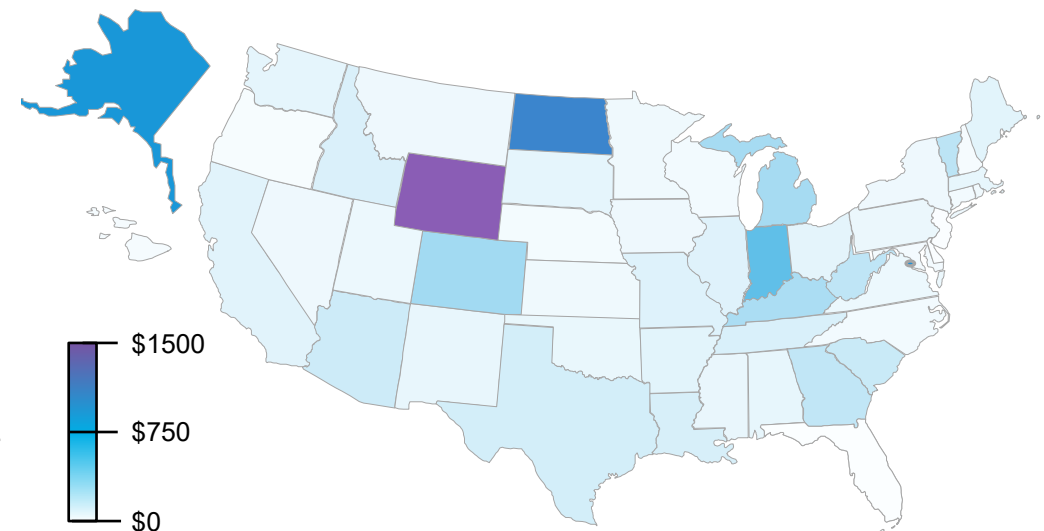
Source: BloombergNEF. Note: Manufacturing capacity is based on nameplate capacity and includes manufacturing for fully commissioned capacity for multiple segments such as electric vehicles, stationary storage and others.

# Deployment: Federal investments

## Federal energy funding by state and sector, 2021-24



## Per-capita federal energy funding by state, 2021-2024

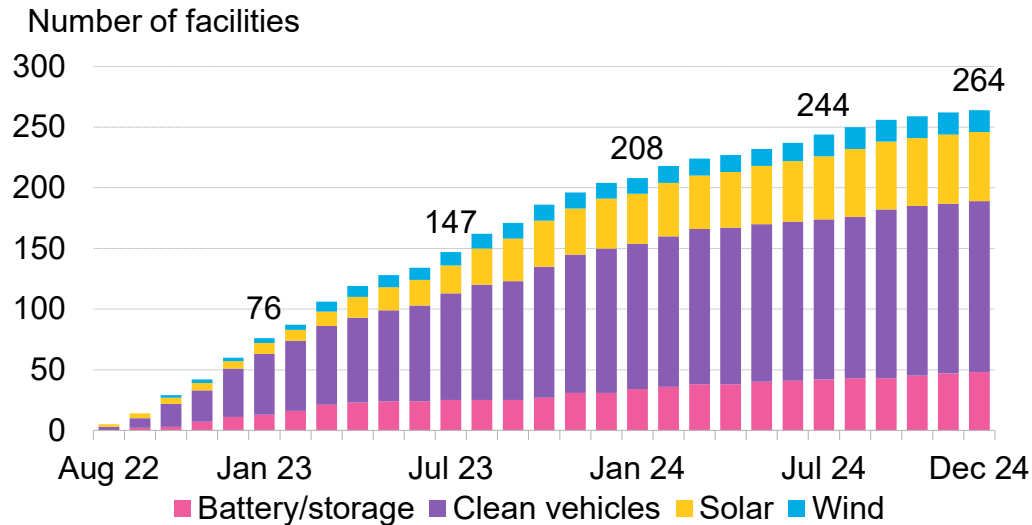


- According to US Department of Energy data, between 2021 and 2024 the federal government invested \$99 billion in energy transition sectors. This includes loans that were supported through loan guarantees, but not tax credits.
- Batteries and electric vehicles together accounted for \$34 billion of this funding, the bulk of which took the form of loans from the Advanced Technology Vehicles Manufacturing Loan Program. Over 60% of this subset of funding was concentrated in three loans to BlueOval, Starplus and Rivian.
- Two loan guarantees to utility projects collectively accounted for \$17.5 billion of investment. Pacific Gas & Electric benefited from a \$15 billion loan guarantee for its Project Polaris, a portfolio of projects including expanding hydropower generation and battery storage, upgrading grid capacity and enabling virtual power plants. Similarly, Wisconsin Electric Power Company received a \$2.5 billion loan guarantee to invest in wind, solar, storage and hydropower.
- The grid (\$9.0 billion), hydrogen (\$7.5 billion) and nuclear (\$5.7 billion) were also sectors that took in significant chunks of investment.

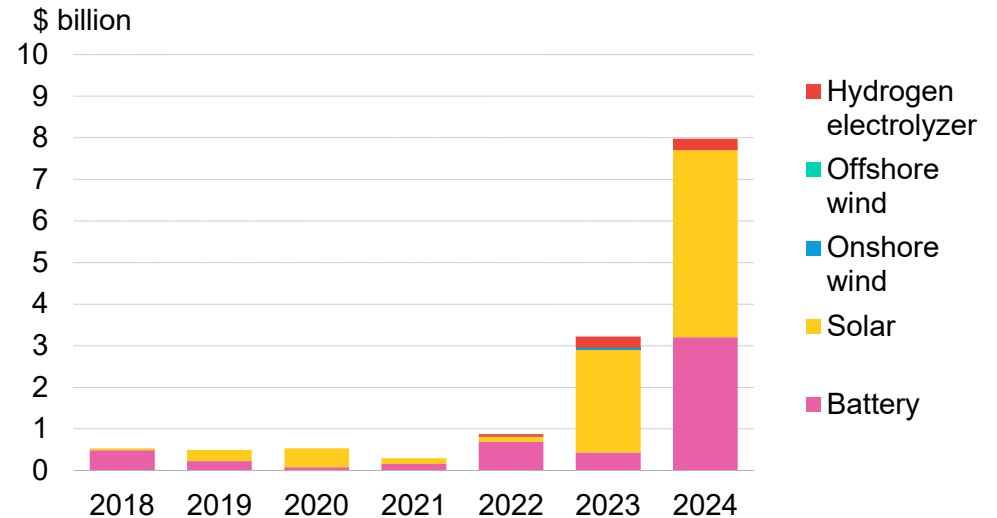
Source: US Department of Energy, Invest.gov, BloombergNEF. Note: CCS/DAC refers to carbon capture and storage and direct air capture.

# Deployment: Clean-tech manufacturing investments

## Cumulative clean-tech manufacturing investment announcements in the US, post-IRA



## Annual clean-tech manufacturing investment in the US

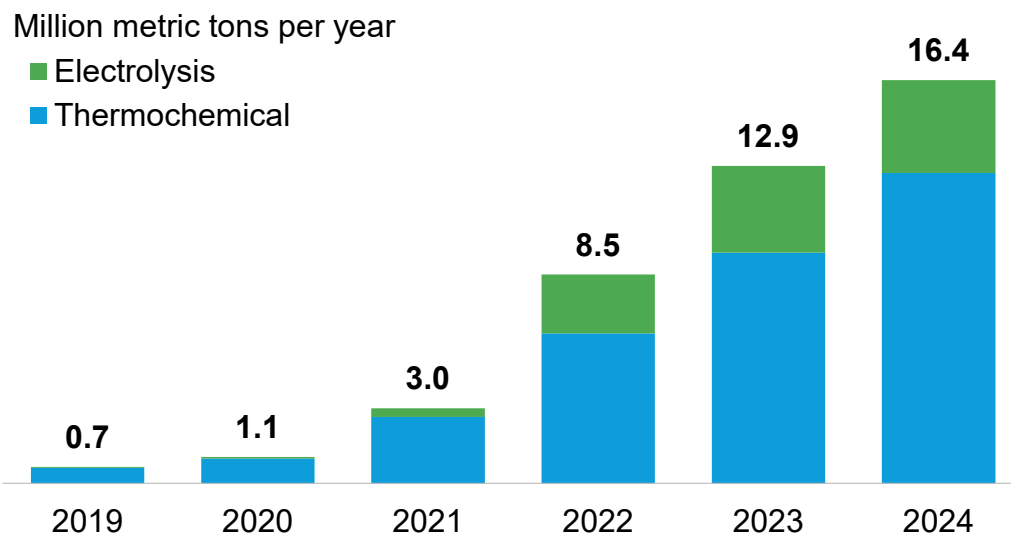


- Since the passage of the Inflation Reduction Act, a total of 264 clean-tech manufacturing investments across four sector supply chains have been announced in the US. The pace of new announcements has slowed: of the 264 projects, only 60 were announced last year.
- Onshoring is picking up. BNEF estimates that \$8 billion (right chart) went into bringing online clean-tech manufacturing in the US across supply chain segments for the hydrogen electrolyzer, wind, solar, and battery sectors in 2024. The substantial increase in this total since 2022 was driven by the commissioning of factories announced in the wake of the IRA. Factory subsidies, local content rules and import tariffs drive the case for domestic manufacturing.
- Inexpensive imports, the lack of experience of many manufacturers, and political uncertainty surrounding the IRA's incentives threaten the US factory pipeline. Despite the flurry of activity in the last two and a half years, there is no guarantee that all of the announcements will lead to factories being commissioned.

Source: E2, BloombergNEF. Note: The chart on the left includes factory investment announcements across the manufacture of solar (including components), wind (including components), battery/storage (mineral extraction and processing, battery components, battery cells and packs), clean vehicles (EV battery components and assembly, vehicle components and assembly, and EV chargers). The Inflation Reduction Act (IRA) was signed into law on August 16, 2022. The chart on the right includes factory investment across the manufacture of solar (polysilicon, wafers, cells and modules), batteries (separators, electrolytes, cathodes, anodes and cells serving both the EV and stationary energy storage markets), wind turbines (nacelles only), and hydrogen electrolyzer manufacturing (stack assembly only). Investment derived from estimated capex of factories commissioned in the years shown.

# Deployment: Regional hydrogen hubs to increase supply

## Cumulative hydrogen project volumes, by year of project announcement



## Regional hydrogen hubs' planned H2 production facilities

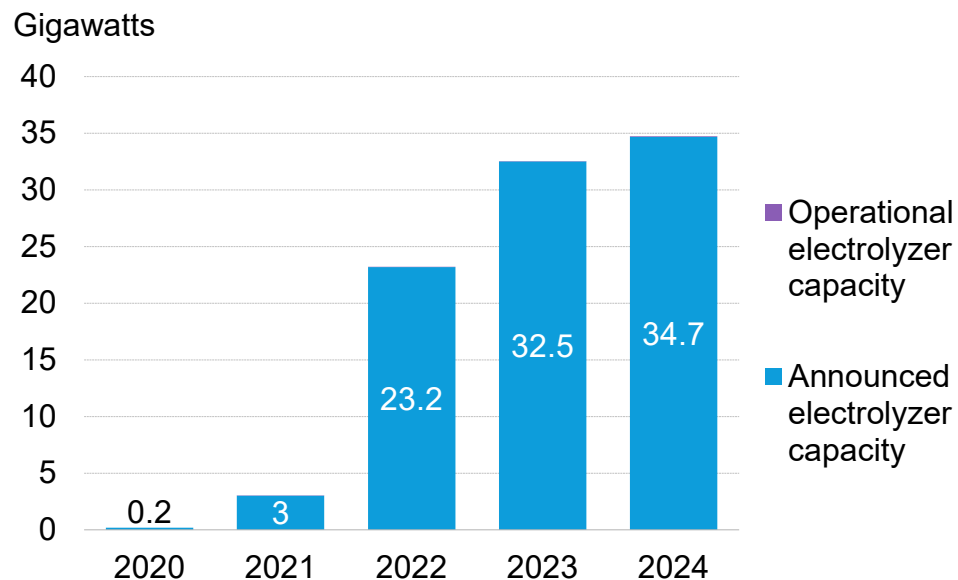


- Clean hydrogen project developers spent 2024 waiting for final guidance on the Inflation Reduction Act's 45V tax credits. The guidelines finally arrived in early January 2025, but a change in energy priorities with the incoming administration meant that even the rules' publication couldn't alleviate uncertainty in the sector. As of January 2025, funds (but not tax credits) appropriated through the IRA and IIJA have been paused.
- Nevertheless, plans for new capacity additions grew in 2024, with approximately 16.4 million metric tons of hydrogen capacity per year announced across the US. Total announced capacity grew 27% year-on-year from 2023 to 2024 in anticipation of federal support. The \$7 billion regional hydrogen hubs program moved forward; as of January 17, 2025, all seven hubs have progressed to phase one of the program receiving a total of \$170.5 million to kickstart project planning and analysis.
- About 77% of the US's announced low-carbon hydrogen is 'blue', produced from natural gas with carbon capture. The low cost of US natural gas makes blue hydrogen far less expensive to produce than 'green' hydrogen (produced using renewable electricity) despite the generous \$3/kilogram 45V tax credit.

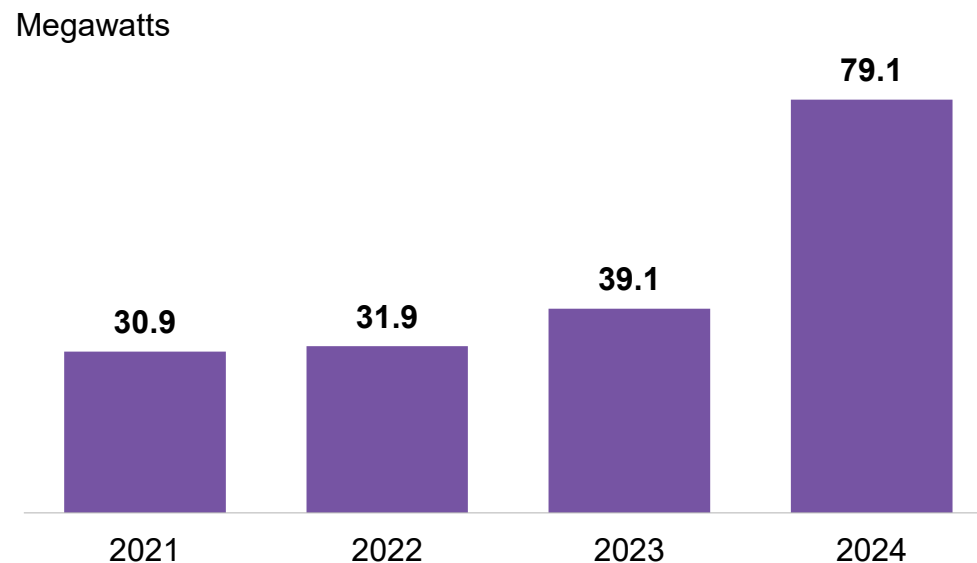
Source: BloombergNEF, Office of Clean Energy Demonstrations (OCED).

# Deployment: Operational electrolyzer capacity on the rise

## US electrolyzer capacity announced and operational, by year



## Operational US electrolyzer capacity by commissioning year

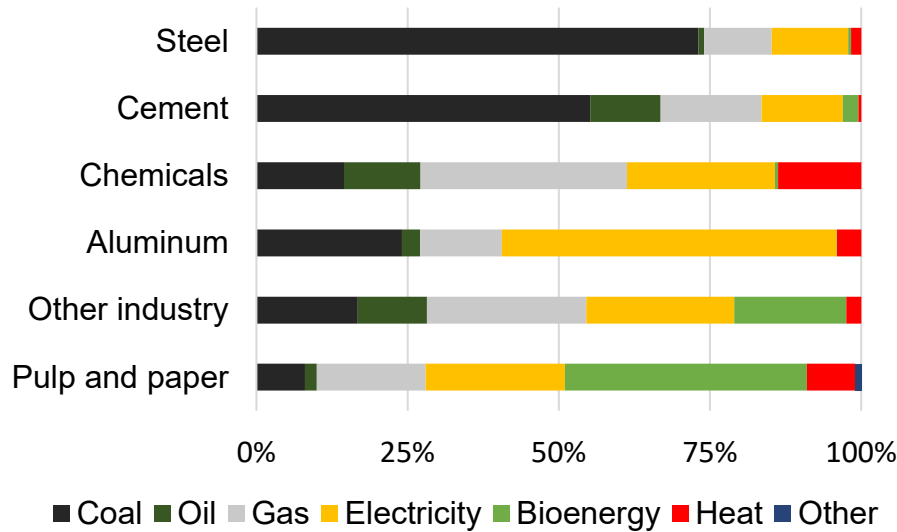


- Last year, developers announced plans to bring 34.7GW of electrolyzer capacity online to produce ‘green’ hydrogen in the US in the coming years, a 7% increase in announced volumes over 2023. However, as the industry spent the entirety of 2024 awaiting final guidance on the 45V hydrogen production tax credit – key to determining final production costs – actual operational capacity grew to the far smaller 79MW. The US green hydrogen market today has six operational green hydrogen facilities; 90% of their capacity was brought online by a single firm, Plug Power.
- The cost of producing green hydrogen in the US currently exceeds that of producing blue hydrogen, which makes the tax credit key to project economics. The tax credit will provide up to \$3 per kilogram of hydrogen produced for projects that meet lifecycle carbon emissions criteria and comply with the so-called ‘three pillars’ of incrementality, temporal matching and deliverability. Electrolyzer projects stand to benefit the most from this credit, while ‘blue’ hydrogen developers are likely to opt for the 45Q tax credit for carbon capture and storage. That said, the arrival of a new administration in Washington leaves the fate of the tax credit uncertain, despite the release in January 2025 of the final rules governing 45V eligibility.

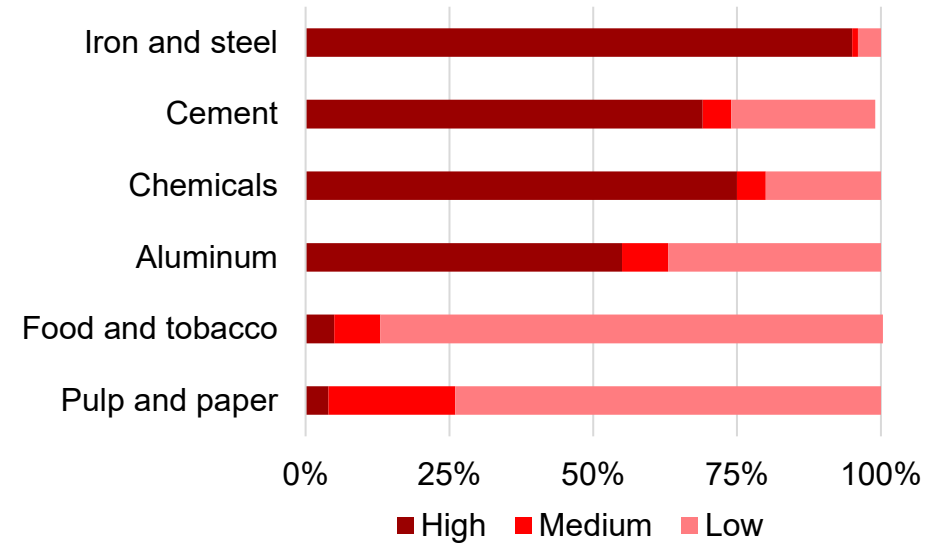
Source: BloombergNEF. Note: Data is estimated based on publicly available information as of January 17, 2025.

# Deployment: The role of heat in industrial processes

Share of energy supply for industrial processes globally, 2022



Temperature profile for industrial process heat globally, 2022

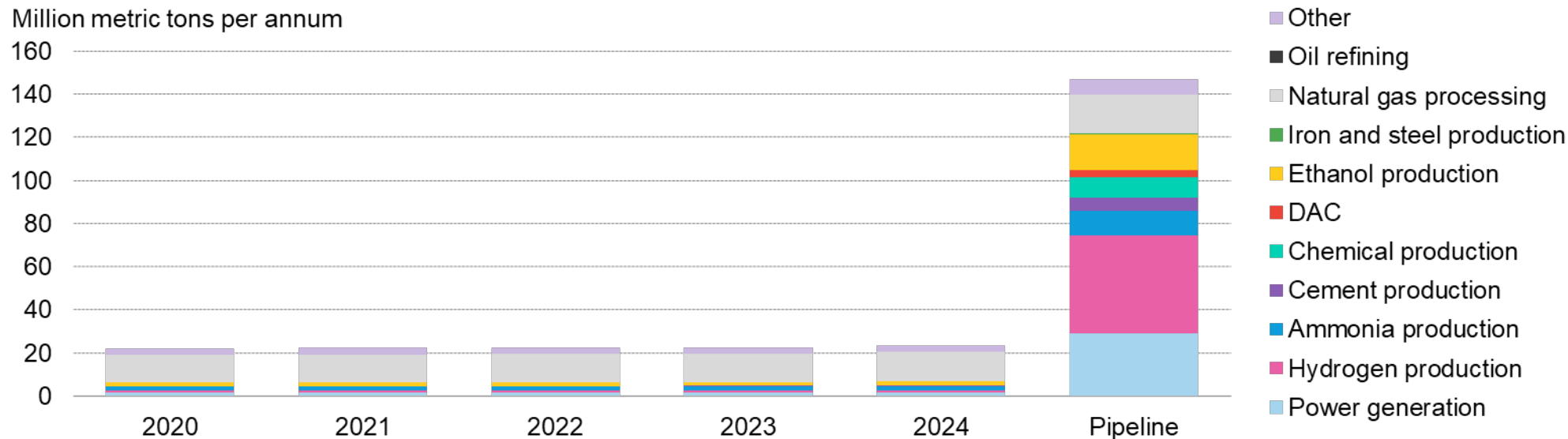


- Industrial processes accounted for 32% of global energy use in 2022 and around one-fifth of all greenhouse gas emissions. Most industrial energy consumption is used to produce process heat.
- In 2024 the Office of Clean Energy Demonstrations (OCED) awarded \$6.3 billion through its flagship green industry award, the Industrial Demonstrations Program (IDP), to industrial pilot projects. The funding was designed to support the first, most expensive projects, thereby helping these technologies scale. Some projects involved alternate ways to produce process heat.
- Among the winners was the electrification of medium- and low-grade process heat, particularly for the food and beverage sector and for industrial heat pump and power-to-thermal storage technology. While less technically challenging to decarbonize than high-grade heat, these industrial retrofits remain at early stages. New projects with major brands like Unilever, Kraft-Heinz and Diageo may provide essential market validation and a bridge to mass adoption for new technologies, such as Rondo Energy’s renewables-powered heat batteries

Source: BloombergNEF, International Energy Agency, Energy Balances, European Commission. Note: 'Other' in the chart on the left includes food processing, manufacturing and construction

# Deployment: US deployment pipeline for carbon capture projects

## Historical and proposed carbon capture capacity in the US, by source



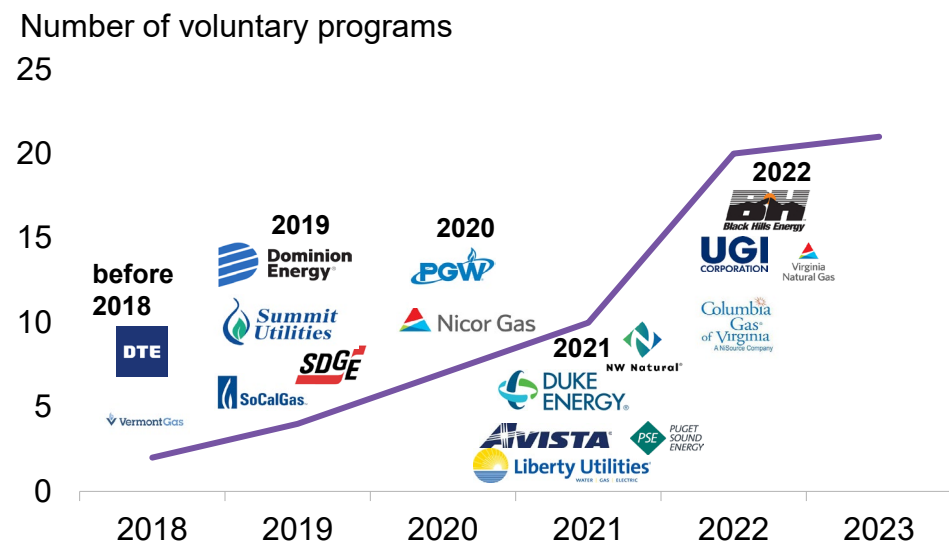
- The US had nearly 23 million metric tons of CO<sub>2</sub> per annum (Mtpa) of installed carbon capture, utilization and storage (CCUS) capacity at the end of 2024. Most of this capacity is used in the natural gas processing sector, but the CCUS landscape is diversifying rapidly.
- Currently, the US has 146Mtpa of announced capacity expected to come online through 2035. Sectors like ethanol, power generation, ammonia and hydrogen, and chemicals make up most of the demand from these plans. But regulations from the Internal Revenue Service for the 45Q tax credits are still missing, and this lack of action is bridling the market.
- The absent 45Q criteria and the impending election created a stagnation in the market throughout 2024. Few new projects were announced, paralleled by no projects moving forward with a final investment decision. There was instead a notable increase in project cancellations with developers citing unfavorable economics, and in the case of direct air capture (DAC), an inability to secure 24/7 clean power due to heightened data center competition.
- The DOE has however been active, particularly in the fourth quarter of 2024, in distributing funds from both the Regional DAC Hub program, and from the Industrial Demonstrations Program which subsidized cement and chemicals projects planning on employing CCUS. These initiatives are bolstered by 45Q credits which, despite the mentioned roadblocks, cement the US as the global market leader through 2030.

Source: BloombergNEF. Note: DAC is direct air capture.

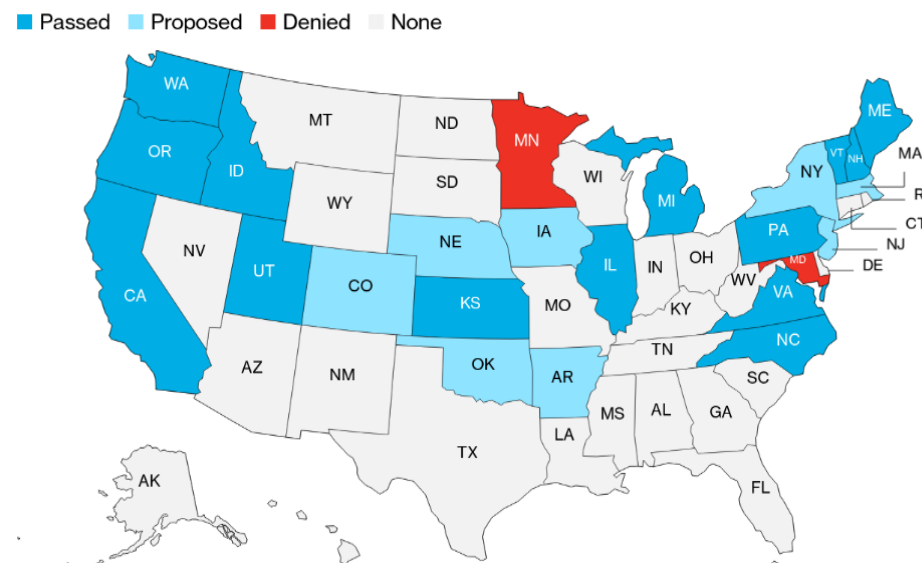


# Deployment: Natural gas utilities spark voluntary demand for RNG

## Gas utilities selling RNG



## Green gas tariff availability



- The residential and commercial sectors are a large portion of the gas utility business, accounting for 46% of demand from the 20 largest publicly traded gas utilities analyzed by BNEF. As of 2024, 17 gas utility companies now have regulatory approval to sell renewable natural gas (RNG) to customers using a special tariff mechanism. These tariffs, referred to as green gas tariffs, enable utility customers to offset all or a portion of their natural gas usage with RNG.
- To meet customer demand, gas utilities are signing long-term offtake agreements with RNG developers. For example, Avista Corp. announced a deal with Pine Creek RNG to procure enough gas to serve 8,500 customers. But obtaining the approval to sell RNG is not always easy. For example, CenterPoint Energy's proposal to sell RNG in Minnesota was denied over tracking and verification concerns in addition to costs.
- Cost is another big factor. BNEF estimates that the median incremental price customers must pay to get RNG is \$3/MMBtu.

Source: BloombergNEF, American Gas Association RNG Activity Tracker, company press releases and websites. Note: Some prices estimated based on US monthly average usage of 6 million British thermal units (MMBtu). RNG is renewable natural gas.

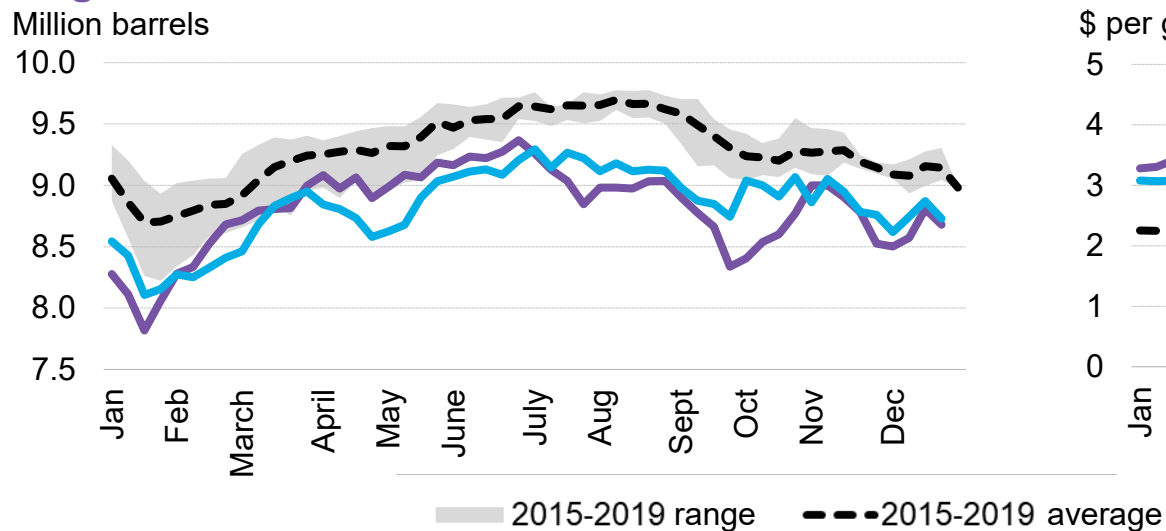
# Table of contents



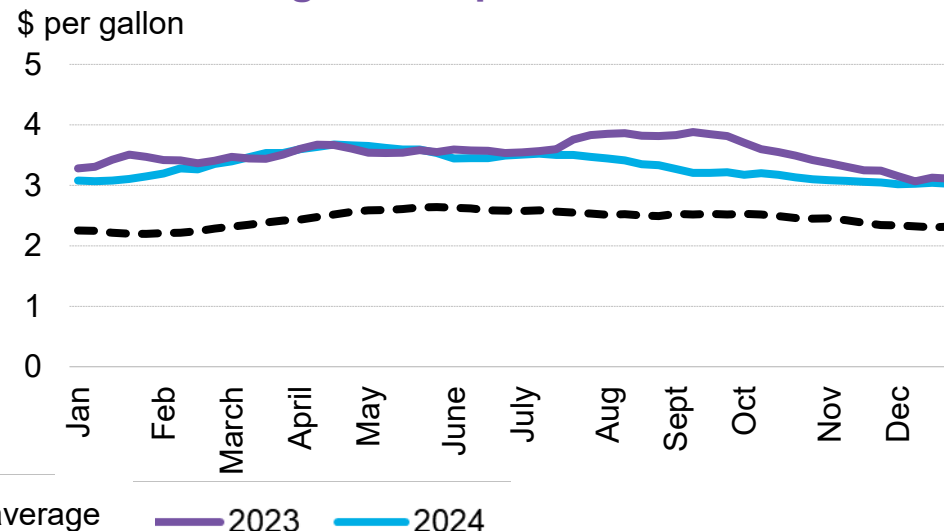
<u>1. Executive summary</u>			
<u>2. A look across the US energy sector</u>			
<u>3. Policy</u>	<u>3.1 Infrastructure and emissions</u>	<u>6. Deployment</u>	
	<u>3.2 Tax credits and stimulus</u>		
	<u>3.3 Vehicle standards</u>		
<u>4. Finance</u>	<u>4.1 Energy transition investment</u>		<u>7. Transportation</u>
	<u>4.2 Utility investment</u>		
	<u>4.3 Corporate sustainability</u>		
<u>5. Economics</u>	<u>5.1 Levelized costs of electricity</u>	<u>6.1 Energy efficiency</u>	
	<u>5.2 Environmental markets</u>		
			<u>6.3 Solar and wind</u>
		<u>6.4 Storage</u>	
		<u>6.5 Hydrogen</u>	
		<u>7.1 Gasoline</u>	
		<u>7.2 Fuel prices and EV sales</u>	
		<u>7.3 Renewable natural gas</u>	

# Transportation: Gasoline demand and prices

## US gasoline demand



## US wholesale gasoline prices

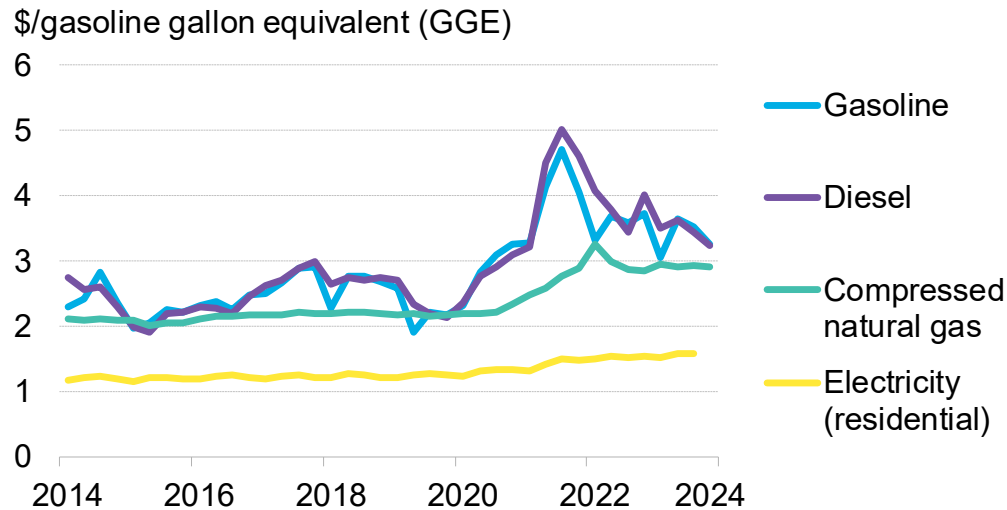


- US gasoline demand was below 2023 levels in the first half of 2024 but reversed course to rise above 2023 levels in the second half of the year. Nonetheless, it remained well below pre-pandemic (2015-19) averages. The US consumed an average of 8.84 million barrels a day (b/d) of gasoline in 2024, a modest year-on-year increase of 32,000 b/d and 440,000 b/d lower than the 2015-19 average.
- Higher gasoline prices are a large part of the reason US gasoline demand has been below pre-pandemic levels. Wholesale US gasoline prices averaged \$3.33 per gallon in 2024, \$0.88 per gallon higher than the 2015-19 average. US drivers are price sensitive, and higher gasoline prices have led to reduced consumption. Elevated gasoline prices were partially a result of lower global refining capacity, as a number of refineries were shuttered over the previous years owing to weak refining margins. This limited refined product supplies as economies around the world reopened after the pandemic and consumption of refined products recovered, leading to higher gasoline prices.
- There are also structural factors at work that have led to lower US gasoline demand. Many workers across the US retain some work-from-home flexibility, reducing the need to commute to work and denting gasoline consumption.

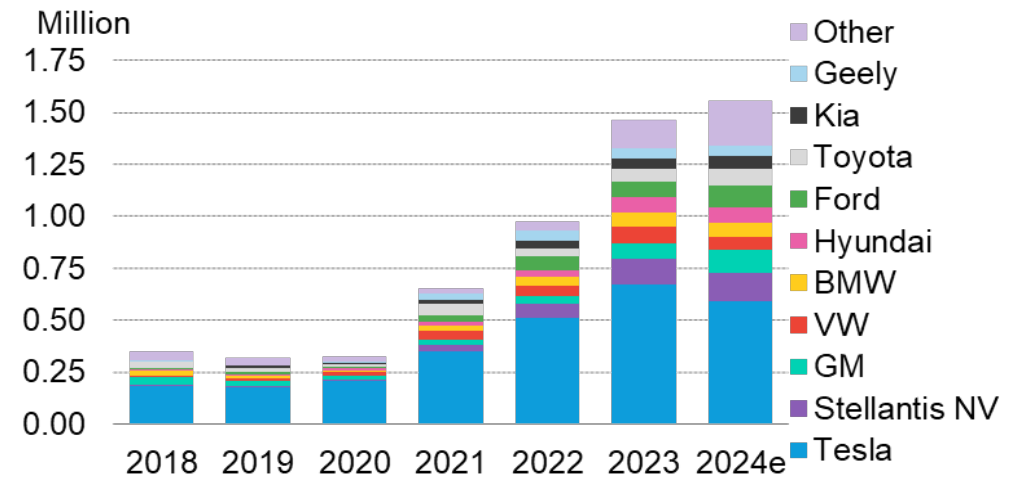
Source: BloombergNEF, US Energy Information Administration, American Automobile Association. Note: Gasoline demand data is the four-week rolling average for gasoline supplied data from the US Energy Information Administration. Wholesale gasoline prices are the daily national average gasoline price.

# Transportation: Vehicle fuel prices and EV sales

## Average vehicle fuel prices



## US electric vehicle sales



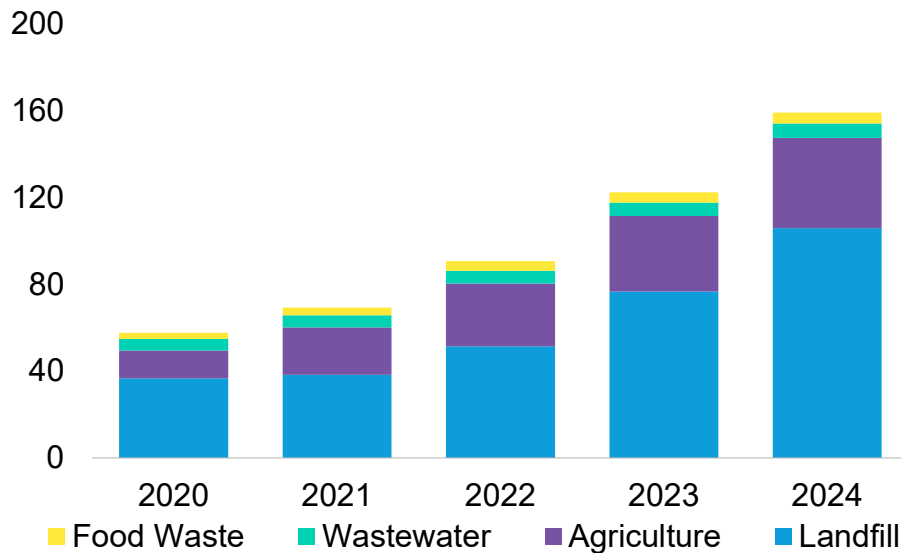
- Gasoline, diesel and compressed natural gas (CNG) prices in the US declined in 2024, while residential electricity prices rose for the fourth year in a row. Despite the increase in electricity prices, refueling a car with gasoline remained twice as expensive as powering an electric vehicle. While gasoline prices averaged \$3.41 per gallon in the first three quarters of 2024, down 3.3% from \$3.53 per gallon in the same period in 2023, consumers paid about \$1.56 per gasoline gallon equivalent (\$/GGE) for charging their electric car.
- Last year marked a slowdown in the US EV market. Passenger EV sales still grew compared with 2023, yet only at a rate of 6.5%, as opposed to a 50% growth rate the previous year. Still, with an estimated 1.55 million electric cars sold in the US last year, every one in 10 cars sold in the country came with a plug.
- Slower EV adoption in the US was in part down to lackluster sales of Tesla EVs, which fell by around 11% compared with 2023. Tesla's aged model lineup meant that the automaker sold around 70,000 fewer EVs in the US in 2024 than in 2023. Still, domestic automakers did their best to fill in the Tesla gap, with EV sales from GM and Ford increasing by 50.5% and 36.4% year-on-year, respectively. Excluding Tesla, the passenger EV market in the US went up by nearly 22% last year.

Source: BloombergNEF, Marklines, US Department of Energy, US Energy Information Administration. Note: Electricity was converted from residential prices to \$/gasoline gallon equivalent (GGE). Efficiency metrics used included 1 kilowatt-hour = 3.54 miles driven and 1 kilowatt-hour = 33.7 GGE.

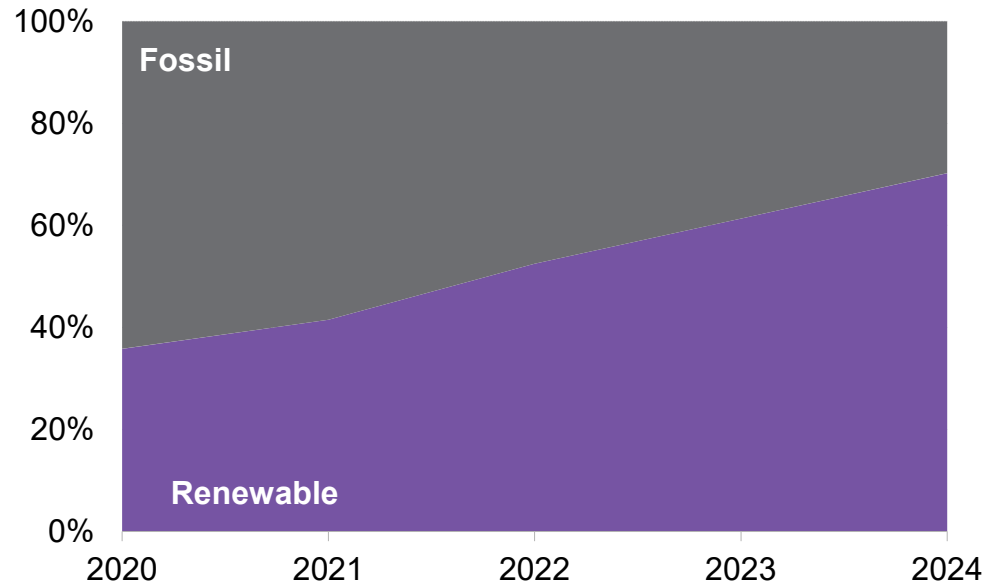
# Transportation: Renewable natural gas supply and vehicle demand

## US renewable natural gas supply

Trillion Btus per year



## US natural gas vehicle demand, by source

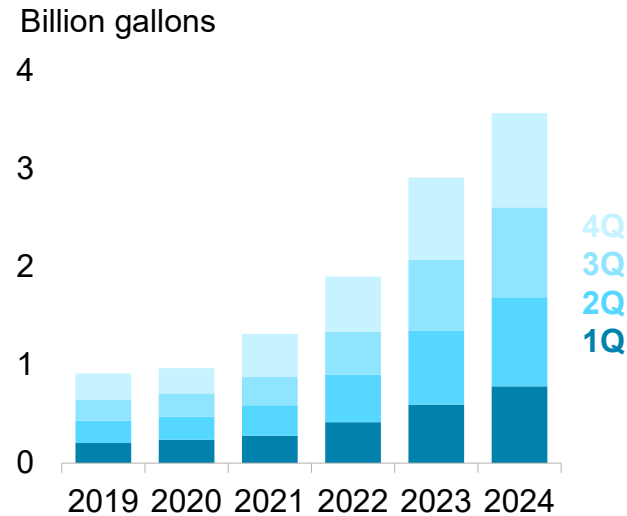


- Renewable natural gas (RNG) supply has grown swiftly over the past decade, driven by market-based incentives such as the Renewable Fuel Standard (RFS) and the California Low Carbon Fuel Standard (LCFS).
- The capacity of RNG in the US grew 30% year-on-year in 2024, led by additions from landfill gas and agriculture projects.
- Demand for RNG within transportation, the largest end-use market by volume, grew 14% year-on-year in 2024. However, the total number of compressed natural gas and liquified natural gas (CNG/LNG) fueling stations fell 13% from 2019 to 2023, according to data from the Alternative Fuels Data Center.
- This implies total demand from natural gas vehicles in the US is shrinking while the supply of RNG is growing. As a result, BNEF estimates RNG made up 70% of all fuel for natural gas vehicles in 2024, double the share in 2020.

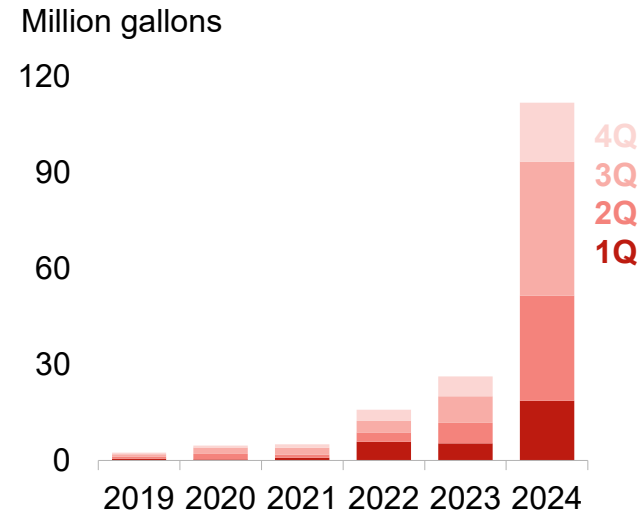
Source: Supply data provided from the American Biogas Council. Demand based on data provided from Environmental Protection Agency and Alternative Fuels Data Center.  
Note: Btu stands for British thermal units.

# Transportation: Renewable fuel supply continues to climb to new highs

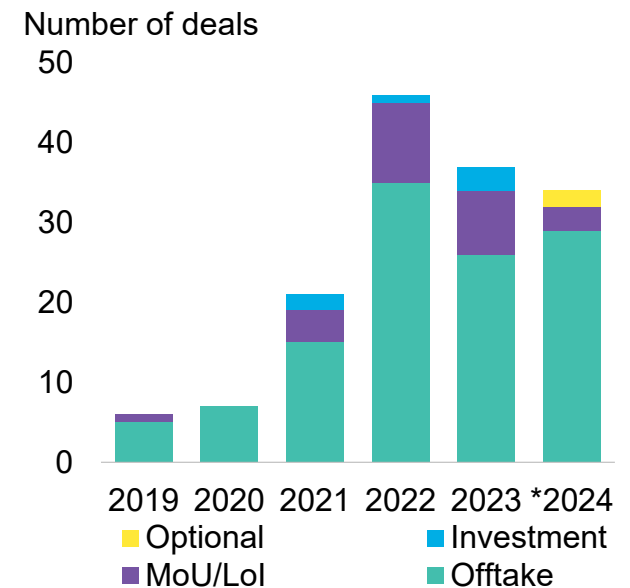
## US renewable diesel supply



## US SAF supply



## Airlines SAF offtake agreements



- Renewable diesel supply continues to grow strongly year-on-year, with 2024 volumes up 25% compared with 2023. Domestic production, which now accounts for 89% of US supply, rose to 3.1 billion gallons, a new record, as new facilities continue to ramp up production.
- Renewable jet fuel supply soared in 2024, rising 325%. Government incentives such as investment tax credits under the IRA are driving renewable jet fuel production. Demand for such fuel is increasing among some airlines' corporate customers, especially those looking to reduce their scope 3 carbon emissions.
- Globally, airlines signed a total of 34 agreements to procure sustainable aviation fuel (SAF) from January to early December 2024, marking another year of decline. Since airlines cannot absorb the higher cost of SAF they need to carefully balance purchases with demand from customers trying to offset scope 3 emissions.

Source: BloombergNEF, EPA, company press releases, ICAO, US Securities and Exchange Commission. Note: SAF stands for sustainable aviation fuel, Lol stands for letter of intent, MoU stands memorandum of understanding. 2024 SAF data covers agreements announced January 1- December 3, 2024.

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